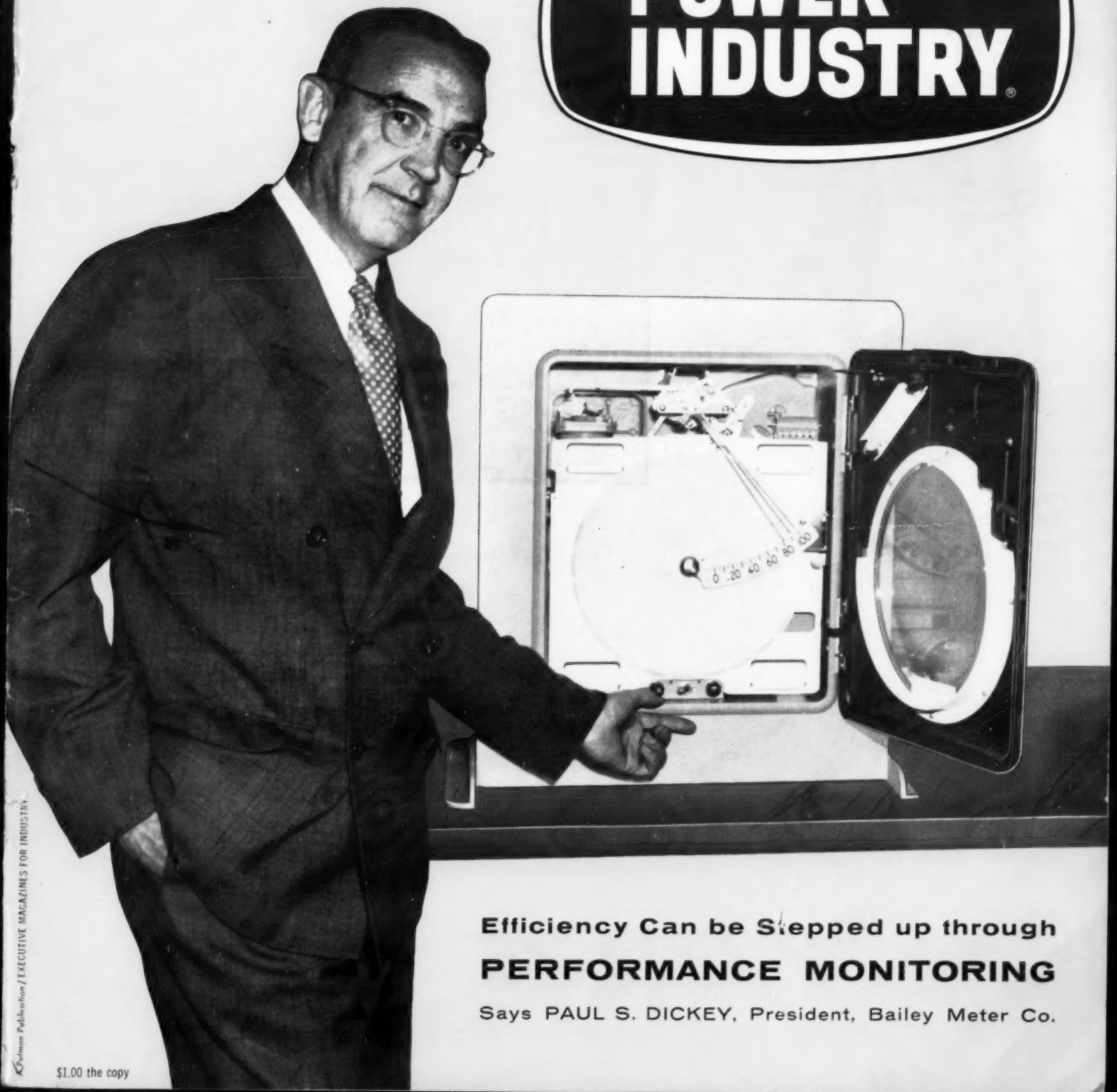
DECEMBER 195

**STEAM TURBINES...**
which type for which job?
Page 12

# POWER INDUSTRY®



**Efficiency Can be Stepped up through**

## PERFORMANCE MONITORING

Says PAUL S. DICKEY, President, Bailey Meter Co.

Coleman Publication / EXECUTIVE MAGAZINES FOR INDUSTRY

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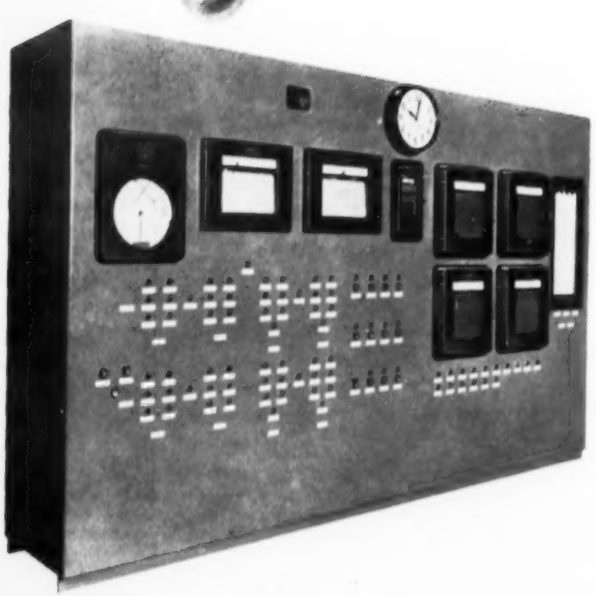
# INFILCO DEMINERALIZATION EQUIPMENT...

## *ENGINEERED to meet YOUR requirements for HIGH PRESSURE BOILER FEED*



*Control Panel, Commonwealth Edison Company, Will County Station, Joliet, Ill.*

- **Maximum reliability**
- **Highest quality water**

Check some of these installations. They are representative of INFILCO's advanced engineering and development in providing water suitable for today's (and tomorrow's!) high pressure steam generators in the utility field.

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**California Electric Company,** Highgrove Plant ... Highgrove, Calif.
**Commonwealth Edison Company,** Crawford Station ... Chicago, Ill.
**Commonwealth Edison Company,** Will County Station ... Joliet, Ill.
**Commonwealth Edison Company,** Station No. 6 ... Waukegan, Ill.
**Chicago District Electric Generating Corp.,** State Line Station ... Hammond, Ind.
**Interstate Power Company,** Dubuque Station ... Dubuque, Iowa
**Municipal Gas & Electric Department,** Holyoke Plant ... Holyoke, Mass.
**Omaha Public Power District,** North Omaha Station ... Omaha, Neb.
**Central Power & Light Co.,** Lon C. Hill Station ... Corpus Christi, Texas
**Central Power & Light Co.,** Victoria Station ... Victoria, Texas
**Wisconsin Power & Light Co.,** Rock River Station ... N. Beloit, Wis.
**Wisconsin Power & Light Co.,** Edgewater Plant ... Sheboygan, Wis.

It will pay you to investigate. Write today for Bulletin 1960-C.

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# Power Industry

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Volume 73 No. 7 December 1957



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Advertising Representation
will be found on page 51


The power services include the production, transmission, and application of all forms of energy — steam, electricity, mechanical power, pneumatic, hydraulic — and engineering maintenance for the power services in the following:

- Public Utilities
  - Central Stations
  - Engineering Headquarters
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  - Waterworks
  - Atomic Energy
- Manufacturing and Mining
  - Chemical and Process Industries
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  - Food and Kindred Products
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BPA NBP

FOR THE POWER SERVICES MANAGEMENT TEAM

# POWER INDUSTRY

VOLUME 73 NO. 7 DECEMBER 1957

**Efficiency Can Be Stepped Up Through Performance Monitoring** 11

Bailey Meter Co. president Paul S. Dickey calls for greater economies in power productioon through better application of basic instrumentation plus greater use of automatic data processing systems.

**Steam Turbines — Which Type For Which Job?** 12

Steam turbines are most widely used industrial prime movers because of their ability to supply both mechanical and heat power. Here is down-to-earth advice on their adaptability, reliability.

**How To Select Nuclear Pumps And Motors** 14

What criteria are most important in selecting pumps for high-pressure, high-temperature nuclear power plants? Here are tips from an expert at Allis-Chalmers Mfg. Co.

**Dependable Water Supply Gives Shutdown Insurance** 16

Tidewater Oil Company refinery eliminates water supply problems with a dependable system that draws cooling water from nearby Delaware River for all process uses. Pure water is discharged to river.

**Compact Control Centers Reduce Distribution Losses** 18

General Mills, Inc. concentrates electric distribution system components and recording temperature instruments close to control points for the accurate control needed at its Toledo food processing plant.

**Insulating Expansion Joints With Standard Techniques** 20

Straight-line insulation is simple – but expansion joint insulation can be tough. Here's how one mining company attacked this problem – and came up with some workable solutions.

**Power Basics For Today's Industry** 22

Part V continues to examine phenomena of conduit flow, but with special emphasis on problems of turbulently flowing fluids. Valve throttling action and minor losses are considered.

**Power For Uranium Mining** 35

Power production in northwest Saskatchewan 450 miles south of the Arctic Circle presents many special problems. Nordberg diesels furnish the needed power for mining and utility needs; exhaust gas produces steam.

## monthly features . . .

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Designed for high-volume air movement against resistances ¾" S.P. Featuring new, wider 4-blade "Macheta" Airfoil propellers, "LS" fans are available in ring, duct or square panel types. Standard construction features mean lower initial costs, with more efficient operation. Aerovent "LS" fans are the practical solution to all standard air-moving problems. Special motors, propellers, coatings available for corrosive conditions.

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Ash and Boyd Sts. Piqua, Ohio

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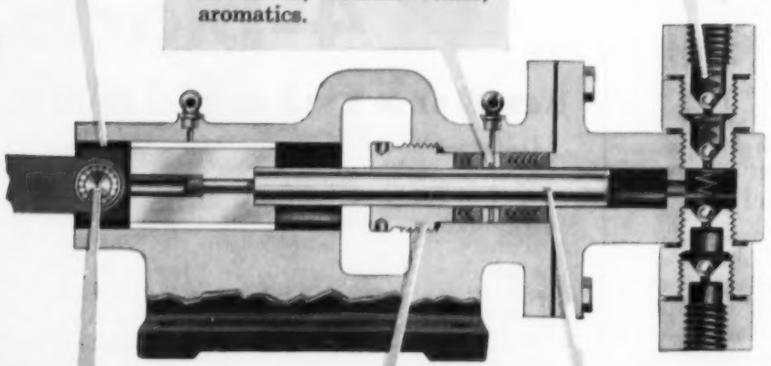
# PICK THIS PUMP
## for reliability and maintenance economy...

**CROSS HEAD** is oversized, running in carefully machined guide—preventing usual pump failures at this point. All moving parts and packing can be removed without breaking piping connections.

**LIQUID ENDS:** Valves are machined from solid stainless steel. No pressed seats to work loose. Valve balls are hardened and ground, and stainless steel spring-loading insures instant response, even on viscous liquids and slurries.

**LANTERN RING** readily changed from grease to water or oil seal for handling crystallizing liquids, slurries, corrosives, volatile toxics, aromatics.



**CONNECTING ROD BEARINGS**—hardened and ground pins running in grease lubricated needle bearings, replace the usual rapidly-wearing bronze bushings.

**PISTONS** are stainless steel, ground and polished. Accurate capacity control is obtained by piston stroke length adjustment. Adaptable to both manual control and instrumentation.

**PACKING GLANDS** are easily accessible at both ends to simplify packing replacement. Gland take-up is a screwed nut, insuring even pressure on packing—no cocking, less packing trouble.

*For more facts about Philadelphia type S Pumps — for 85% of all chemical pumping needs — write for Bulletin S-1254.*

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**PHILADELPHIA PUMP**

DIVISION OF AMERICAN METER COMPANY / EST. 1836

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## PI that's interesting

### Protects pipelines, ships from corroding sea water

Automatic electric system permanently protects tidal hydroelectric turbines, submerged pipelines, ships' hulls and propellers against sea water corrosion by a neutralizing flow of chemically created electricity. Heart of the CAPAC system is

silver-chloride monitor cell. Cell governs controller that supplies reverse voltage to platinum anodes placed at strategic points. System installs on old or new equipment, needs no service or maintenance, can be salvaged at any time. Charles Engelhard, Inc., is originator.

### Clock is powered by solar energy

Hoffman Electronics Corp. has presented first solar-powered clock to Palm Springs, Calif., Chamber of Commerce. Twenty silicon solar cells around clock face convert sun's light energy into usable electric energy. Storage batteries charged by the solar cells hold sufficient electricity to operate clock at night.

### Titanium can't harm lubricants in storage

U. S. Army tests show that titanium and its alloys can't hurt lubricants kept in long-term storage. Titanium exerts only a slight catalytic influence on lubricants. Most bearing metals and alloys in long contact with greases and oils act as catalysts in accelerating lubricant oxidation or chemical decomposition.

### Teflon seat doubles valve sealing ability

Arrangement of Teflon seat insert doubles efficiency of new ACF Industries Inc. valve. Double-seal valve handles petroleum products from heaviest viscous fluids to lightest gases at pressures to 5000 psi. Teflon insert won't flow; is immune to acids, alkalis, petroleum fractions; won't vulcanize; needs no lubrication.

### Motor exhaust can be purified — at a price

General Motors Corp., cooperating on air pollution control research activities, reports 90% reduction of nitrogen oxides in car exhaust by using richer fuel mixture in carburetor. But car testing richer air-gas mixture used 4.1 gpm more gas than car with standard carburetor. Another bug — new carburetor produces higher carbon monoxide concentrations in exhaust. Possible solution to purer exhaust: catalytic converter (to dispel carbon monoxides and unburned hydrocarbons by catalytic oxidation) plus richer fuel mixture in carburetor.

### Consumption of crude rubber lags

While 127,500 more tons of man-made rubber was consumed this year over last, 25,000 fewer tons of crude rubber was used. Increasing production of man-made rubber in U. S. and Western European nations plus continuing high crude rubber prices account for decline in crude rubber consumption, according to B. F. Goodrich Co. spokesman.

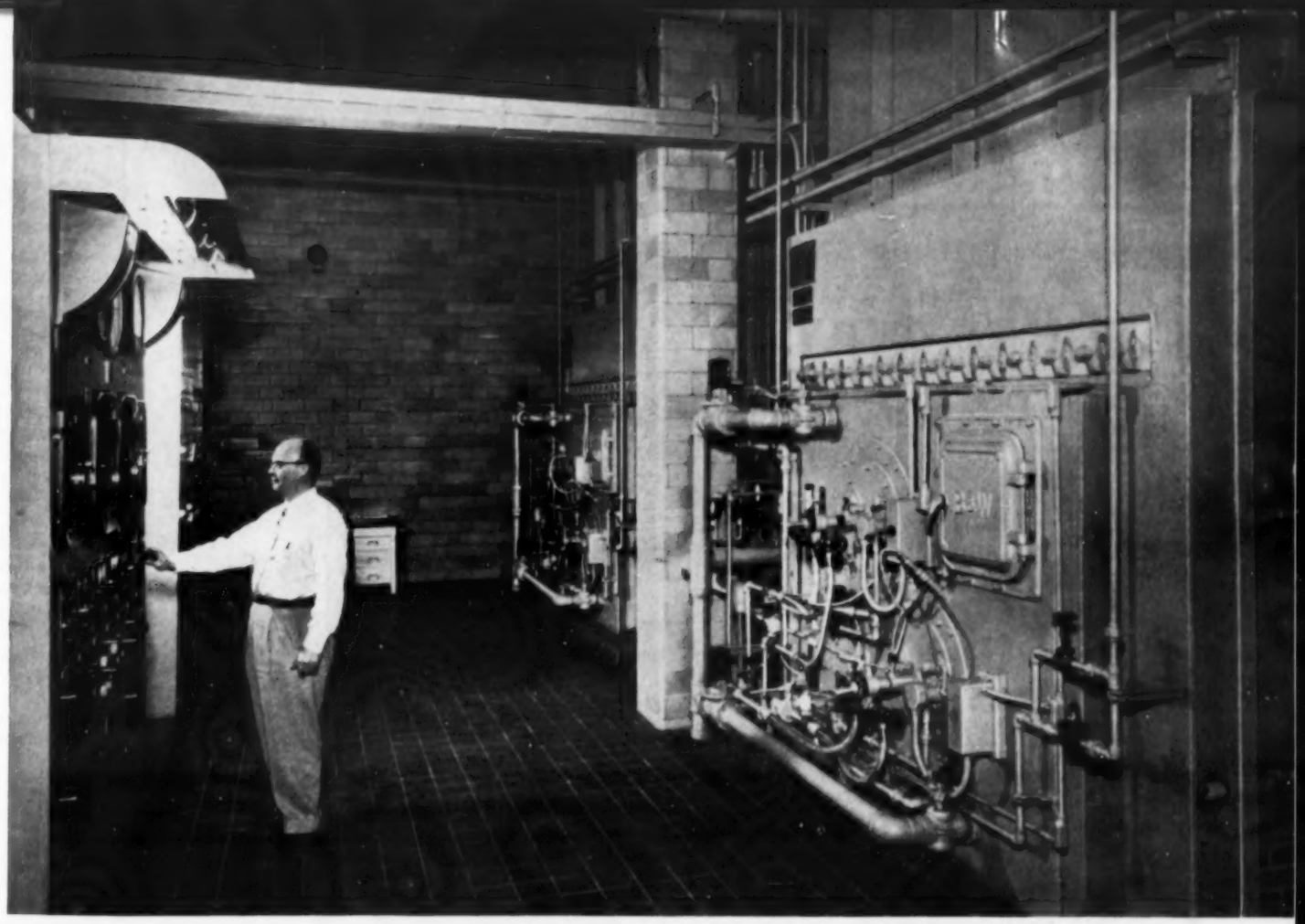
### Sun-powered water pump for desert

A water pump, powered by solar energy, has been developed by Hoffman Electronics Corp. Pump uses a solar energy convertor of silicon solar cells. This development is envisioned as an answer to desert irrigation.

### New element discovered

Discovery of element No. 102 has recently been announced, according to Arthur D. Little, Inc.'s Industrial Bulletin. A target of curium (element 96) was bombarded by greatly accelerated ions of a heavy isotope of carbon (element 6), to produce the new element in one step. Otherwise it would be necessary to use target elements of even higher atomic number, which are difficult to produce.

Circle 1107 on Reader Service Card for more data

# Hospitals Turn to B&W Integral-Furnace Boilers for Reliable Supply of Clean, Dry Steam

Every day, year after year, even the routine activities of a hospital are vital. The continuous, reliable services expected from hospitals must be matched by the equipment upon which they depend.

Institutions like St. Mary's Memorial Hospital at Knoxville, Tenn., have come to depend upon the reliability and continuity of operation offered by B&W Integral-Furnace Boilers. Cleanliness of operation, high fuel economies, and maximum capacity in small boiler room space are other benefits of these units which appeal to health and budget-conscious hospital management.

Modern, efficient steam supply with ample capacity for future needs, which include a new 105-bed wing and 150-bed nurses' residence with classrooms and auditorium, are being provided at St. Mary's Hospital by two new B&W Boilers.

Flexibility of the B&W Integral-Furnace design is another of the many reasons why St. Mary's and scores of other hospitals throughout the country have selected B&W. The new boiler at Knoxville is oil and gas-fired, with provision made for the installation of a stoker for future coal firing.

Rapid response to steam demands, dependable supply of clean, dry steam, and the ready availability of a nation-wide service staff, have given B&W Boilers preference among those who specify and buy for hospitals and institutions throughout the nation.

B&W provides a single responsibility in design, engineering, manufacturing, installation, and service through a national network of plants and engineers.

The Babcock & Wilcox Company, Boiler Division, 161 East 42nd Street, New York 17, N. Y.

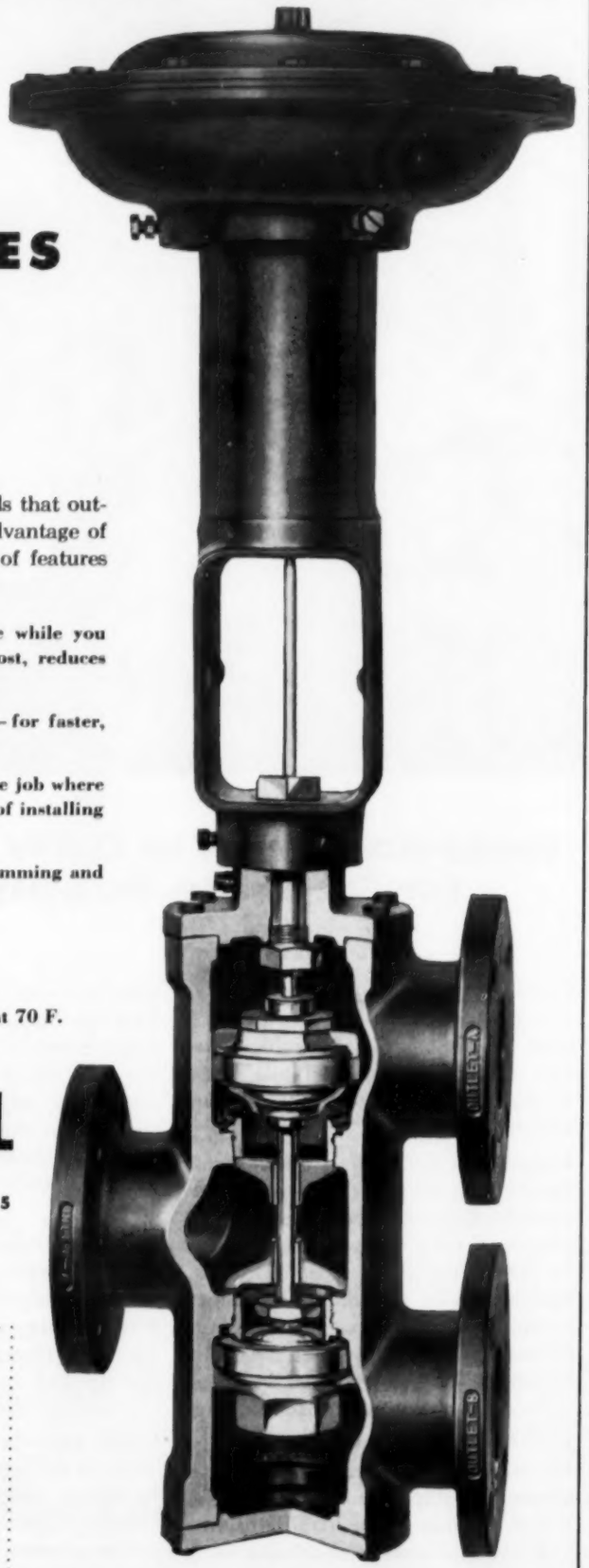
Two B&W Integral-Furnace Boilers at St. Mary's Hospital have capacity of 30,000 lb. of steam per hour each at operating pressure of 110 psi. Design pressure of 160 psi. Architect: David B. Liberman, Knoxville, Tenn. Consulting Engineer: Albert F. G. Bedinger, Knoxville, Tenn.

G-851-FF

BABCOCK & WILCOX BOILER DIVISION

# Improved Design Beats High Installation and Service Costs!

## *new* THREE-WAY BY-PASS VALVES *by* JOHNSON



Here's a new line of Three-Way By-Pass Valves for liquids that outperforms and outsaves them all! It's another exclusive advantage of Johnson Pneumatic Control Systems! Check the lineup of features below and mail the coupon for full details today.

- **"In the line" servicing**—valve stays in place while you install new discs and seat rings. Cuts upkeep cost, reduces downtime.
- **Allows simplified, straightaway piping** — for faster, easier, less costly installation. No elbows needed.
- **100% tight-closing design**—*one* valve does the job where ordinarily *two* are needed. Save the cost and time of installing a second valve.
- **Both discs seat against flow**—eliminates slamming and water hammer.
- **Proportional or two position action.**
- **Sizes**—2½ to 6 inches.
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Please send me Bulletin Nos. V-210 and V-211 describing your new Three-Way By-Pass Valves.

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Address_____
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## POWER INDUSTRY reports . . .

### Kaiser Engineers awarded AEC power plant contract

Kaiser Engineers, Oakland, Calif., receives Atomic Energy Commission contract to design natural uranium, graphite-moderated, gas-cooled 40,000-kw nuclear power plant. First progress report, including cost estimates and construction schedules, must be submitted by the AEC to the Joint Congressional Committee on Atomic Energy by April 1, 1958. Kaiser Engineers has retained ACF Industries, Inc., for nuclear design.

### Convergatron eliminates nuclear reactor runaway

Dr. Lyle B. Borst, New York University physics department chairman, discloses development of a new design for nuclear power plants that eliminates reactor runaway danger. Design combines a uranium and water system with a convergatron reactor. Because uranium and water cannot produce a full chain reaction no matter what their proportions, reactor runaway threat is abolished. System would be operated by adding neutrons amplified to level required for power production. Dr. Borst revealed design details at recent American Nuclear Society semiannual meeting.

### New cables insulate high-voltage networks

Three new cables fill requirements of extra high-voltage transmission systems. (Conventional underground cable can only handle up to 70 kv.) Pipe cable consists of conductors surrounded by oil-saturated paper in a lead sheath, as in low-voltage cables. Oil is supplied through connections with reservoirs at regular intervals to maintain adequate oil flow, keeping paper more consistently saturated. Gas cable substitutes nitrogen or other gases under pressure for insulating oil. Oil-filled cable has a hollow channel in conductor center for the oil, supplied from reservoirs.

### B&W places subcontracts on experimental reactor

Babcock & Wilcox Co., prime contractor on AEC liquid metal fuel reactor experiment, announces awarding of three project subcontracts. Union Carbide Nuclear Co. will be consultant on chemical processing of uranium-bismuth liquid – fuel for the experimental reactor. Walter Kidde Nuclear Laboratories, Inc. will design and manufacture remote maintenance and handling equipment that will permit operators to work at specified distances from the reactor. A. D. Little, Inc. will study continuous uranium concentration measuring system feasibility. Anticipated advantage of liquid metal fuel reactor concept is that fuel circulates inside reactor rather than being part of stationary fuel elements. This reduces pressure vessel thickness and eliminates replacing rigid fuel elements.

### Ponder economical means of sea water conversion

Joint research and development project by seven California power generating agencies and the U. S. Department of the Interior will investigate ways of converting sea water to fresh water. Under investigation is process using partly spent low-temperature steam for distillation. Proposed second meeting will proceed with plans for pilot test plant.

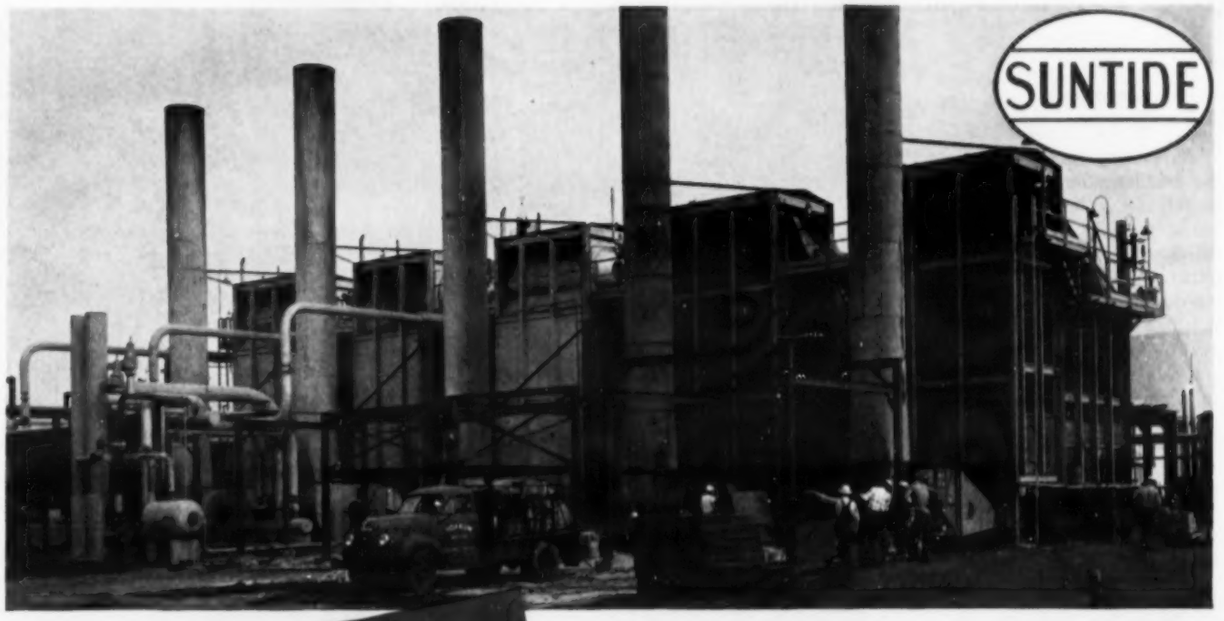
### Future looks bearish for nuclear industry

Sylvania-Corning Nuclear Corp.'s marketing director, Stanley B. Roboff, estimates that the atomic energy industry does not have "enough business to keep all atomic companies operating at, or even near, capacity." Addressing the Atomic Industrial Forum annual conference, Mr. Roboff emphasized that a well-organized marketing program is "one of the key facets of any successful business," and must be recognized as "one of the means of insuring success in the now highly competitive nuclear field." Successful marketing program for nuclear industry must include: surveys of long- and short-range markets; contact


Vogt

# STEAM GENERATORS

at SUNTIDE REFINING COMPANY
Viola, Texas



Above: *Cross Section showing arrangement of steam and water drums, tubes, baffles, and furnace.*

**EFFICIENCY AND ECONOMY PROVED BY FIRST 3 UNITS . . . 2 MORE ADDED!**

**Principle Data Each Unit**

- 85,000 pounds steam per hour capacity, designed for 500 lbs. S.W.P. and 625° F. total temperature.
- Water cooled furnace.
- Burners for Gas and Oil fuel.

Vogt offers a complete line of custom built and package type steam generators. Available in bent tube and straight tube designs for solid, liquid, or gaseous fuels burned singly or in combination.

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**PI reports**
. . . starts on page 6

with all potential customers; good customer relations; development of growing overseas market.

### AG&E negotiates $52-million bank loan

American Gas and Electric Co. has negotiated a $52-million bank loan with 10 leading U. S. banks to help finance projected $670-million construction program. Total generating capacity of completed system will be 6,400,000 kw. Already two generating units with 332,000-kw total capacity have been placed in service as part of expansion program. Projected units include five 225,000-kw units and two 450,000-kw units. Expansion is scheduled for completion in 1960.

### B&W to furnish boiler for Duquesne Light Co.

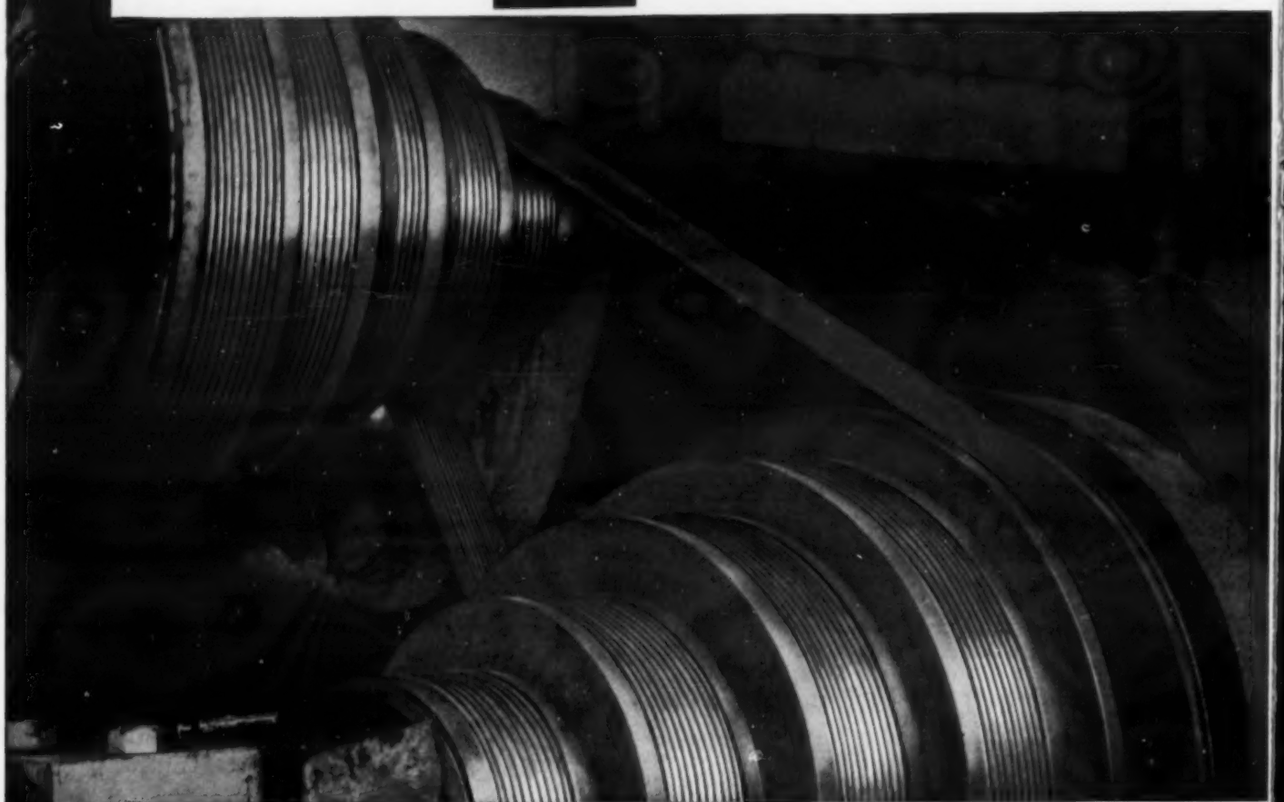
Babcock & Wilcox Co. will supply boiler for $30-million generating unit at Duquesne Light Co.'s Elrama, Pa. station (below). Designed for maximum continuous output of 1,300,000 lb/hr at 2150 psig,

boiler will operate at 1900 psig at superheater outlet with steam and reheat temperature at 1000 F. B&W will also furnish five pulverizers for the boiler, which will burn approximately 75 tons/hr of coal. Boiler will supply steam to a 172,000-kw turbogenerator.

### Feel utilities hurt by government power war

At recent ceremony dedicating Northern Indiana Public Service Co.'s Dean Mitchell generating plant, Indiana's Governor Handley accused govern-


**Users Say R/M BELTS AND HOSE**



**It's *Poly-V*® . . . and Trouble-Free!**

Major causes of drive trouble have been engineered *out* of R/M's patented, new Poly-V Drive. Because it employs a single, endless V-ribbed belt running on sheaves specially designed to mate precisely with the belt ribs, Poly-V delivers more power per inch of drive width than ever before possible! R/M Poly-V delivers up to 50% more power than an ordinary V-belt drive of equal width . . . equal power in as little as ⅔ the width. This means *narrower sheaves . . . less shaft overhang . . . less drive weight* on heavy duty power driven equipment.

R/M Poly-V's single unit belt design also eliminates "length matching" problems and downtime for belt replacements. Poly-V belt speed ratio and belt position remain constant from no load to full load to run smoother and cooler — with *less wear* on belt *and* sheaves! Just two cross sections of Poly-V belt meet *every* heavy duty power requirement: belt and sheave inventories are cut to a new low!

An R/M representative will show you other features of Poly-V* Drive that add up to longer, trouble free service for every heavy duty power drive application.

*Write for Bulletin #6638*

**And . . . for the "Smoothest Running V-Belts Made" Specify R/M CONDOR and SUPER-POWER V-BELTS**

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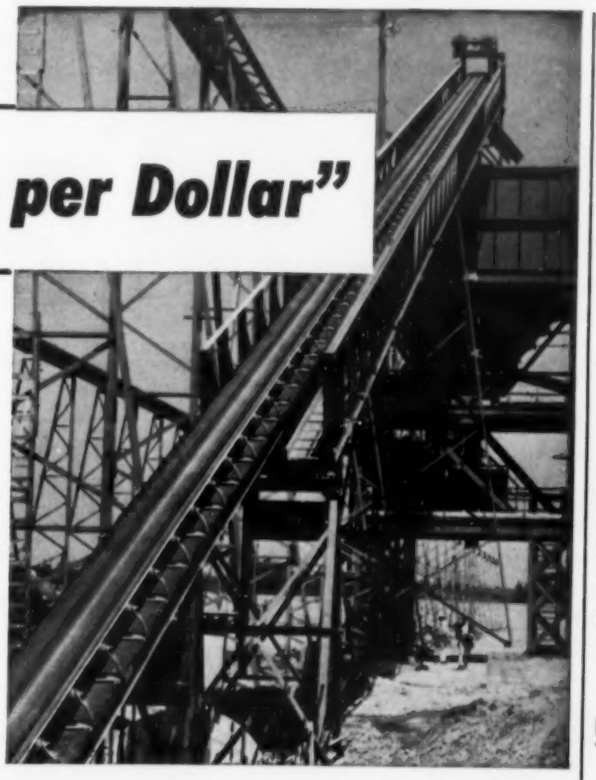
# Give You "More Use per Dollar"



## Allflex Hose—Light, Strong, "Flexible as a Rope"!

This new R/M hose offers a degree of rugged strength with light weight and flexibility not possible with ordinary all-purpose constructions. Allflex hose coils and uncoils freely in *any* direction . . . *without kinking.* Uniform inside and outside diameters permit faster, easier, *safer* coupling. You can't find a longer lasting, easier handling hose for use with air, water, oil and gases—even mild chemicals!

R/M makes a complete line of quality hose for special services, too. Whatever your requirements, you get more use per *hose* dollar from R/M.

*Write for Bulletin #7075*

## R/M Puts the "Extras" in Conveyor Belt Design!

For the conveyor belt *engineered* for your particular job, investigate R/M's advanced developments in heavy duty belt design . . . constructions like extra flexible Ray-Man . . . which trains naturally, troughs easily . . . handles *fuller, heavier* loads even where small pulleys are required in low-head room installations . . . extra-cushioned Homocord, for unusually abusive shock loading . . . R/M Tension-Master for extra long lifts and high tensions. Each belt is mildew-proof and moisture resistant . . . and each is protected by the exclusive "XDC" Cover, R/M's *bonus* extra to greatly increase resistance to wear, tear, cuts and abrasion. *Specify* R/M Conveyor Belts . . . you *get* "More Use per Dollar."

*Write for Conveyor Belt Bulletins*

RM 718

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ment of waging "warfare on the public utilities division of the free enterprise system." According to Handley, the government has increased its generating capacity 76 times in 23 years and has "boldly and brazenly invaded a basic industry developed by private capital, private intelligence, and private management."

### Ohio Valley site bought by Appalachian Electric

Appalachian Electric Power Co. has acquired about 1450 acres along the Ohio River at Apple Grove (Mason County), West Va., for a future generating plant. Company anticipates further location of chemical and other heavy industry in the already highly industrialized Ohio River Valley. Plant construction plans are not yet completed.

### Blaw-Knox to build TVA piping system

Blaw-Knox Co. has been awarded $3,500,000 contract for power piping systems to serve four 150,000-kw steam power units at the Tennessee Valley Authority's Johnsonville, Tenn. power plant. Main steam portion of piping will be 2¼% chromium, 1% molybdenum steel, 14 in. od. Entire installation will be finished by June 1959.

### A-C, RCA to design Model C Stellarator

Princeton University and the Atomic Energy Commission have selected Allis-Chalmers Manufacturing Co. and Radio Corporation of America to design and build experimental Model C Stellarator for research into controlled thermonuclear reactions. Facility will be located at the James Forrestal Research Center.

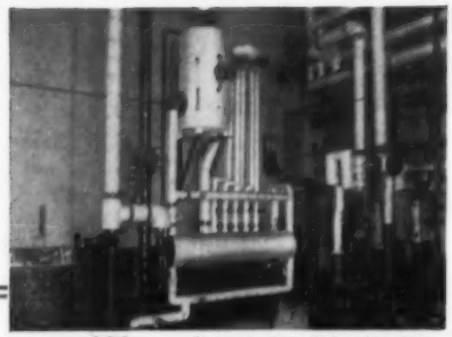
### From the Mailbag . . .

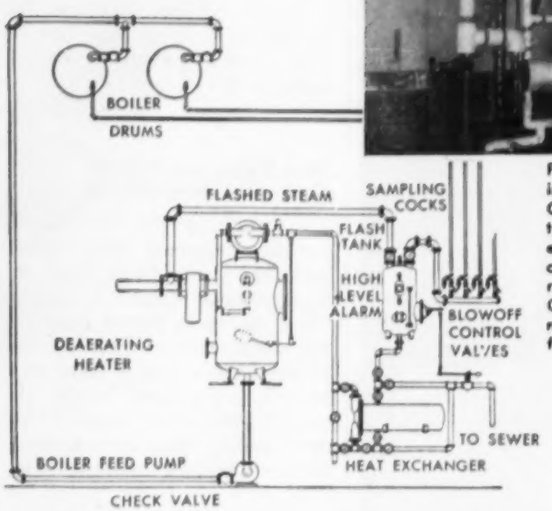
#### Engineering Shortage

"Your invitation for comments brings these viewpoints on our present crop of engineers . . .

"They have a good back-

*(continues on page 50)*






Photograph and drawing showing installation of a Cochrane Class I Continuous Blowoff System of the type most frequently encountered. This sytem is recommended for use where heat recovered from the Cochrane Continuous Blowoff System does not exceed the rating of the feedwater heater.

## *Here are some typical savings with a* Cochrane

## CONTINUOUS BLOWOFF SYSTEM

- A Utility: $15,400.00 annually
- A Sugar Refinery: 3,500.00 annually
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*(Names of companies on request)*

Rising power plant operating costs make complete utilization of heat more important to your company than ever before. With a Cochrane system you can recover practically *all of the heat of the blowoff*. Both flashed steam and heat from hot waste water are returned to the feedwater system.

In addition, Continuous Blowoff provides more uniform boiler concentrations, smoother boiling conditions and cleaner steam.

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# this month's comment . . . .

## . . . more top jobs in power

"The best opportunity for an engineer to get to a top job these days is in the power industry!"

Those were the words Oliver L. Luft, Union Electric Company, said to me across the table at a recent luncheon of the Executive Association of St. Louis.

His remark received a lot of attention, because most of those at the table believed that an engineer's opportunities were better in the electronics industry, or working in the missile and aircraft fields.

But Mr. Luft emphasized that he was referring to *top jobs* – not to recruitment of young men graduating from engineering school.

Here are the reasons . . .

First: About forty or so years ago, the power industry attracted the cream of the crop of young engineers. In both utilities and manufacturing plants, the immediate opportunities for engineers were most obvious. And, the young engineers moved in.

These men have achieved great success. But time moves on, and now most of them are retiring or close to retirement. As a group they occupy almost all the top jobs in the power industry. These jobs are becoming available.

Second: As fabulous as the power industry has been in its growth in the past, the immediate future looks to even more expansion. Nuclear power, complex interconnections, computers and calculators to improve efficiency – these all add to an exciting future as well as great opportunity for the able engineer.

He may wish to join a public utility, or he may prefer to be with a manufacturer. The responsibility for production of power and also for its correct and economical use, wherever it is used, is a responsibility that requires high-caliber men.

When you are in the power industry it's almost like belonging to an exclusive club. Men join up and stay with this club. Compared to other engineering careers, you find but little job changing. Most men advance steadily with the companies they join. And, your power friends are countrywide – men in the power industry freely and happily exchange information.

The opportunities are there. We suggest that you look specifically into them in your own locality. Yes, the engineer's best chance to get to a top job is in the power industry.

John Paul Taylor

John Paul Taylor
Editor

FOR THE MANAGEMENT TEAM
DECEMBER 1957

POWER INDUSTRY

# Efficiency can be stepped up through PERFORMANCE MONITORING

**PAUL S. DICKEY,** President
Bailey Meter Co.

**About**

**Paul S. Dickey**

Paul S. Dickey, president of Bailey Meter Company, joined the company as a cadet engineer in 1925. Before being elected president in 1955, he served as automatic control engineer, research engineer, chief engineer, and vice president.

An active member of the ASME, Mr. Dickey was awarded the grade of Fellow in 1957 because of his outstanding record and contributions in the field of engineering.

A graduate of Purdue University, Mr. Dickey holds three degrees from that university: A BSME, 1925; a professional mechanical engineering degree, 1933; and an honorary degree of Doctor of Engineering conferred upon him in 1953.

Mr. Dickey, who is a recognized authority on power plant and process control, holds more than 50 patents and has had numerous technical papers published in this field.

He is a registered Professional Engineer in the State of Ohio, and in addition to ASME is professionally affiliated with Sigma Xi, Pi Tau Sigma, the Cleveland Engineering Society, the ISA, the executive committee of Recorder Controller Section of the Scientific Apparatus Makers Association, The Society of Naval Architects and Marine Engineers, and the Society of Naval Engineers.

FURTHER IMPROVEMENT of conventional power plant instrumentation as it is known today is fast reaching a point of diminishing returns. To secure better returns, we must secure higher accuracies in basic measurements and make use of automatic data processing.

In the past 15 years, steam power plant instrumentation has made a transition from separate control centers for the boiler, turbine, and feed system to a centralized center serving all three. Remarkable improvements in reliability, flexibility of operation, and in manpower saving have resulted from this centralization.

It is likely that the next major transition will be unification of controls for the entire system. Eventually, this will tie together the boiler-turbine generating units in all the plants of a system and place each succeeding load increment on the unit that can produce it most economically. To move into this new phase we must take the following steps:

First, we must determine and improve efficiency. In the day-by-day operation of the steam-electric generating unit, there is a substantial variation in the efficiency of boiler, turbine, feed heating, and condenser systems. With the best of conventional instrumentation it is often difficult to avoid or to account for these variations. On large steam generating units (above 150,000 kw), these relatively small vibrations in efficiency represent large variations in operating costs. Considerable capital investment would be justified to avoid them.

Second, we must load units economically. Fortunately, the general acceptance of single boiler, single turbine units simplifies continuous determination of overall performance from fuel input to kw output. This factor of continuous unit performance data augments the line-loss penalty factors in establishing the most economical method for economic incremental loading of generating units of interconnected systems. Potential savings through economic loading are sizable today. They will be of far greater importance in the future as unit size increases and transmission systems become more complex.

Third, we must improve heat rate. The importance of improving heat rate can be appreciated more fully when it is interpreted in annual fuel cost. For example, in a recent ASME paper, Paul Matthew of Pacific Gas & Electric Company pointed out that a 1% difference in turbine heat rate for a machine of 165,000-kw capacity operating at a load factor of 90%, would represent an annual fuel cost of more than $35,000.

Finally, in improving system operation we are at the same time making an important step in the essential conservation of natural resources — an item that will be demanded even more in the years ahead.

For present-day large steam generators, the analog-type performance determination method offers a desirable method for determining the performance of the overall steam-electric generating unit. Basically, this is done by computing the unit's input and output. To be more specific, the following factors are significant, and are computed by the Performance Monitor as indices of overall performance.

- New generation in kilowatts or megawatts
- Net heat rate in Btu/kwh
- Net heat rate in dollars/kwh
- Heat rate deviation from reference or test conditions.

Besides these major factors, a performance monitor indicates many intermediate measurements and computations. The end result therefore, will be to supply data that will contribute to improving the complete system.

Performance data, for example, will permit a dispatcher to satisfy system power requirements at minimum cost. Initially, performance data will of necessity be included manually in the load dispatching operation. But we expect that load control, automatically corrected for unit incremental cost rate, eventually will be feasible.

Data supplied to plant personnel will permit operating the plant at the lowest heat rate obtainable. Again, it is expected that ultimately it will be possible to tie-in data processing equipment with the plant's conventional control system.

Complete and detailed performance testing of major units and auxiliaries, on the other hand, calls for the use of data scanning and digital-data-processing equipment. Further, it is likely that this equipment should be portable. It could then be moved from unit to unit to check new units during start-up, and to make periodic detailed performance tests on older units.

*(continues on page 19)*

# Steam Turbines -- which type for which job?

**STEPHEN BENCZE**
De Laval Steam Turbine Co.

STEAM TURBINES are the most widely used industrial prime movers today. This is due to their great design flexibility and ability to extract power from steam and then exhaust all the steam or any part of it completely free of oil into a manufacturing process or heating system. The main justification for the industrial turbine is its relative simplicity, basic reliability, low maintenance cost, and its ability to supply both mechanical power and heat power.

Power cycles are defined as the processes and paths through which a working fluid passes, in a repeated cyclic fashion, in the production of mechanical or heat power. Power cycles are generally classified as either utility, central station, or industrial cycles. In the central station cycle, the prime function usually is to generate electric power. However, many central stations also generate steam for general consumer use.

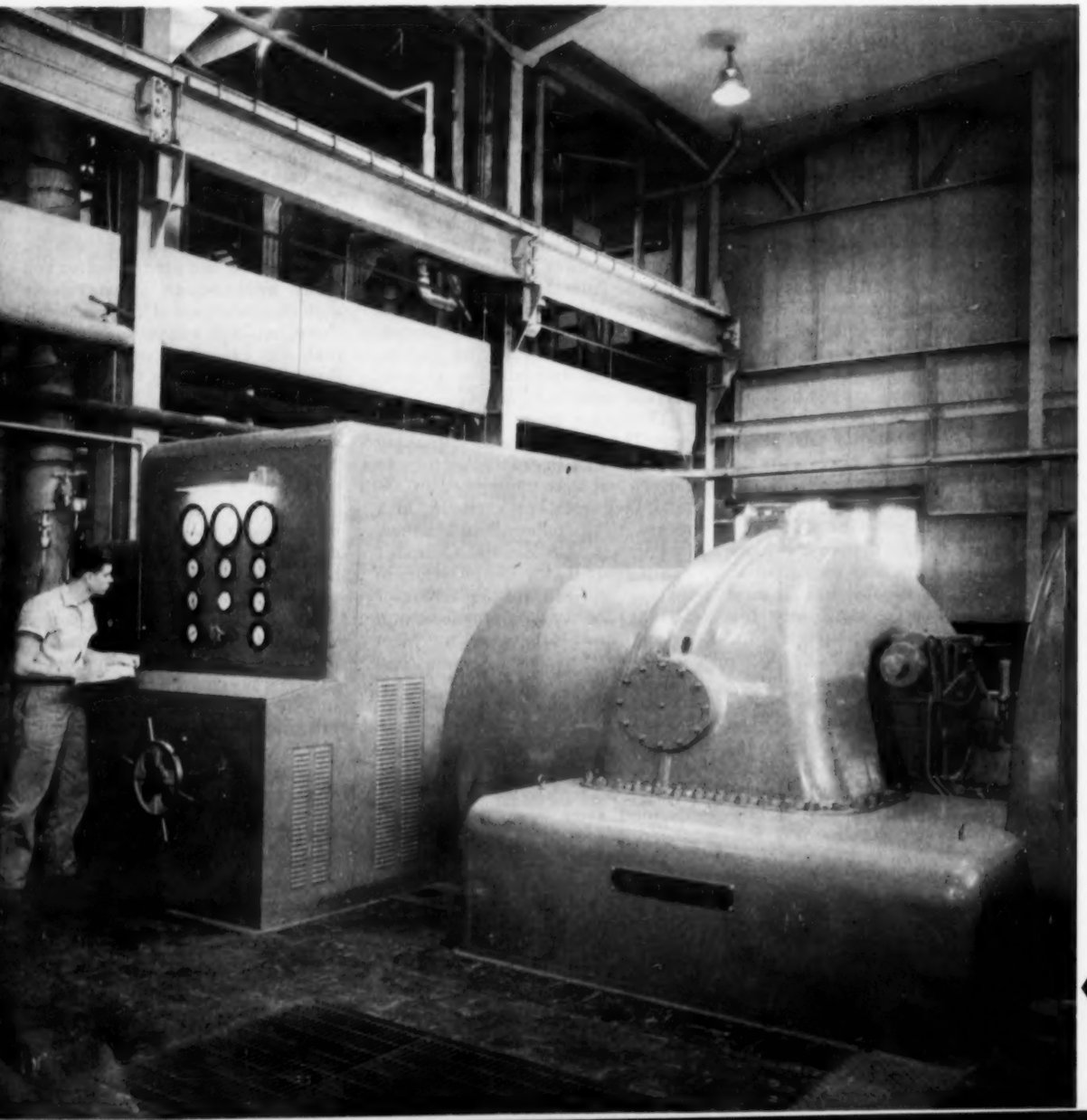
In the industrial cycle (fig. 1), the prime function is two-fold; to generate electric or mechanical power and also steam or heat power, used in various industrial processes peculiar to the particular industry. In this cycle, electric power is generated by the turbogenerator and mechanical power is generated in the turbines driving the boiler feed pumps, forced draft fans, and treated water pumps. This cycle supplements a separate original lower-pressure cycle by furnishing additional process steam and electricity for new chemical processes.

All power cycles consist of three essential elements: the heat source, the heat utilizer, and the waste heat reservoir. There are various forms of heat utilizers, but for our discussion we will consider only the steam turbine. In the industrial cycle, the waste heat reservoir can be the condenser, general plant heating system, or industrial process equipment.

The heat utilizer in the form of a steam turbine in an industrial power cycle serves its purpose in many ways. As a prime mover, it is used to drive ac or dc generators and exciters at constant speed; pumps, fans, blast furnace blowers, air and gas compressors, and others at variable speeds. In addition, it also furnishes process steam as turbine exhaust steam for heating, drying, digesting, or any other process requirement. Industrial power cycles vary widely from the simplest to the most complex. The various types of industrial cycles can be generally classified thus:

- Simple condensing cycle
- Simple non-condensing cycle
- Condensing-Extraction (either controlled or non-controlled)
- Non-condensing-Extraction (either controlled or non-controlled).

The cycle used in each case is determined by the particular require-



*Modern turbines give variety in power, generation, process steam.*

ments of the industry. Electric power and process steam requirements must be considered as well as investment and operating costs. Final selection of power cycle and turbine equipment can be made only after all factors have been closely estimated and the various available alternatives have been analyzed. An understanding of the various types of turbines available assists immeasurably in selecting the type suitable for a proposed application.

### simple condensing cycle

In the industrial field, the simple condensing cycle has limited application. It is used only when there is a demand for mechanical or electric power and no demand for process steam. In this cycle, steam from the boiler passes through the turbine and is converted to mechanical power. All steam passing through the turbine exhausts into the condenser. For industrial power generation, this could be the most expensive way of getting power, because of heat rejected to the condenser circulating water.

There are applications, however, where this cycle has been used and is economically justified. In a continuous industrial process, where there is no process steam demand, and where power interruption must be minimized, this cycle is used for electric power generation or for driving auxiliaries. This could be the case in a public waterworks pumping station.

### simple non-condensing cycle

The simple non-condensing cycle is probably the most widely used in industrial applications. This cycle has wide application where large quantities of steam at fixed pressure are required for industrial purposes or where condensing water is limited or unavailable. Unlike the full-condensing turbine, the non-condensing turbine is not penalized by heat lost to condenser circulating water. Exhaust steam is used for process, and thus power is produced at a very low cost. If all exhaust steam is used, this cycle will produce power at the lowest possible cost, assuming that capital investment charges are not excessive. This cycle is used extensively, particularly when power and steam requirements are nearly balanced.

Small turbines for auxiliary drives are usually non-condensing, exhausting at atmospheric or slightly higher pressure for process, or

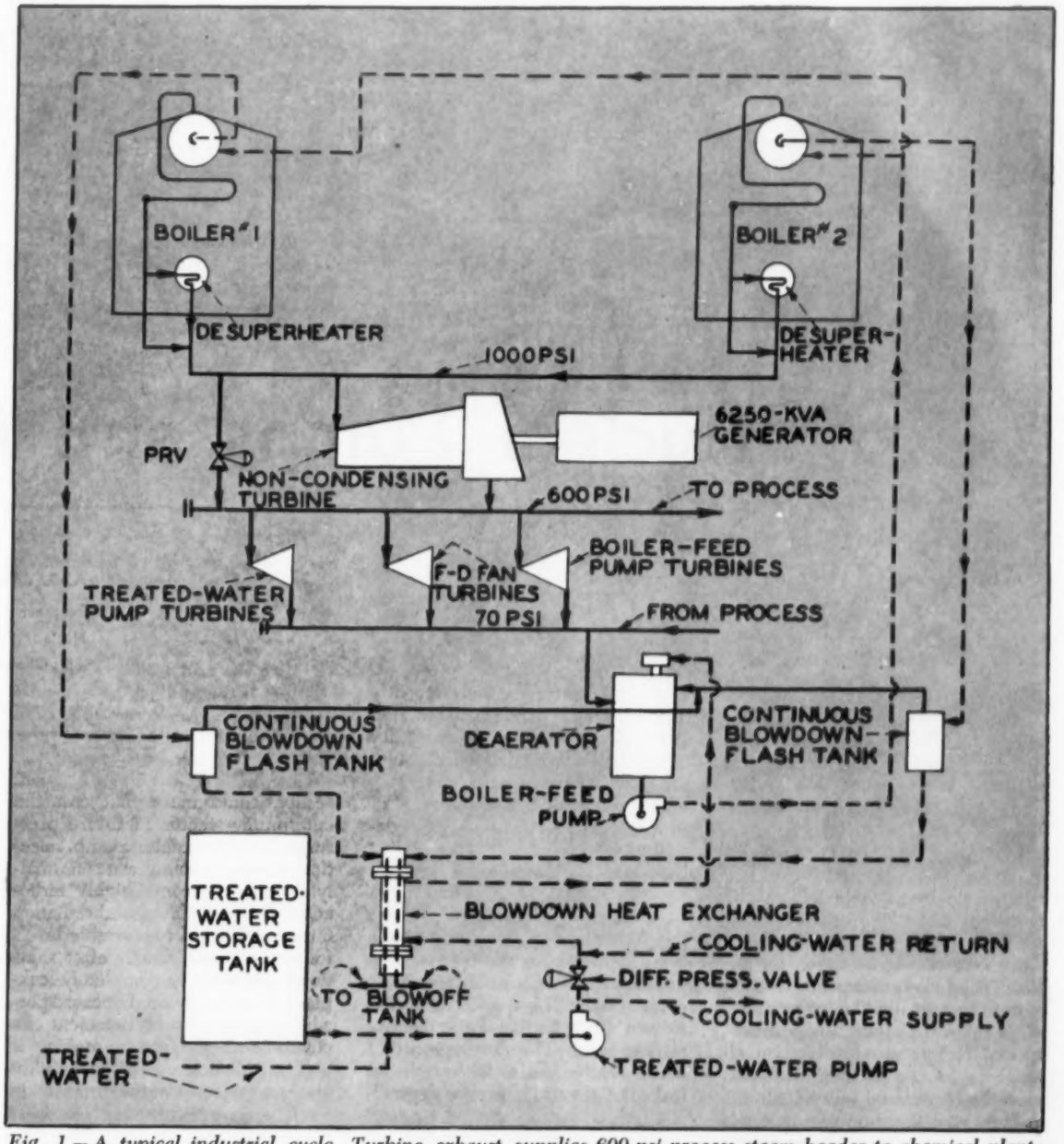



*Fig. 1 — A typical industrial cycle. Turbine exhaust supplies 600-psi process steam header to chemical plant.*

into deaerating feedwater heaters or a heating system. In many cases, these turbines are also used as standby or quick-starting emergency units.

In recent years, the superposed or "topping" turbine has found considerable favor. These units operate at exhaust pressures considerably higher than atmospheric. Generally relatively high efficiency is required. These turbines, therefore, are generally of the multistage type. Small, single-stage units of a much simpler design are also available to drive auxiliaries.

Main application of superposed turbines is to furnish additional power and to improve overall cycle economy. Since boilers usually fail or become obsolete long before the turbines they serve, it is often economically sound to replace old boilers with modern high-pressure high-temperature units. They supply steam to the new superposed turbine. Existing turbines are retained and operated at the same inlet conditions as before, with exhaust steam from the superposed turbine. Considerable increase in power capacity and improvement in economy is obtained with a comparatively small investment. Because of high steam density at high pressures, large amounts of power capability can be built into a turbine and boiler plant of relatively small physical size.

### condensing-extraction cycle

Many industrial plants requiring various quantities of process steam combined with a certain electric power load use an extraction cycle. It is possible to adapt the extraction cycle to a great variety of plant conditions. Many different types of units are available. Automatic or controlled extraction turbines are available with only two extraction points. Uncontrolled or non-automatic turbines, however,

*(continues on page 24)*

**Requirements of today's high-pressure, high-temperature nuclear power plants and forced circulation boilers make pump selection critical. Here are guideposts on . . .**

# How to Select
# Nuclear Pumps and Motors

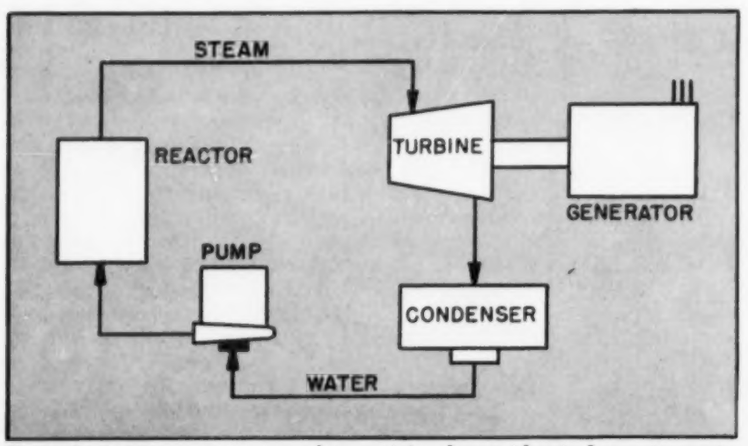
**A. F. ERWIN**
Engineer-in-Charge
Nuclear Pump Section
Allis-Chalmers Mfg. Co.

TODAY, SEVERAL TYPES of nuclear power plants have been developed and are in operation. Among these are the Pressurized Water Reactor, Boiling Water Reactor, Homogeneous Reactor, and Liquid-Metal-Cooled Reactor. Pumps used in reactors for these plants must be able to circulate radioactive materials safely at the required high temperatures and pressures. Selecting main coolant pumps, drives, and controls for nuclear plants requires consideration of most factors affecting conventional pump installations. In addition, special factors are involved in all nuclear plants and their problems must be considered individually.

Main coolant pump requirements for nuclear plants are almost identical to those for boiler recirculating pumps in high-pressure forced circulation boilers. These boilers, until recently, have used buffer seal pumps with cold water injected into the seal at high pressure to permit a pressure drop through the seal labyrinths without flashing steam. They are provided with a mechanical seal to contain leak-off for return to the system. The buffer seal has not been entirely satisfactory in the higher pressure conventional plants. Uncontrolled cold water inleakage to the system through the seal reduces thermal efficiency and increases boiler feed problems.

These seals have high maintenance cost and unpredictable dependability.

Several central stations recently have installed hermetically sealed (canned motor) pump units for trial as boiler recirculators, although their initial cost is considerably higher than buffer seal pumps. For similar reasons, including the desirability of complete sealing against leaks and for maximum dependability, canned motor pumps have been selected as standard in submarines and other ships. They also have been specified for the 60-Mw Duquesne Light Co.'s Shippingport plant and the 275-Mw Consolidated Edison Co.'s Indian Point central station plant. The development of better buffer seals, with reduced leakage rates and improved dependability, could make first cost the determining factor in future pressurized water reactor pump selection. Primary cooling water normally does not become highly radioactive in these plants, and radiation intensity falls off to tolerable levels for maintenance shortly after shutdown. However, a completely leakproof design is favored because possible rupture of a fuel element can contaminate the water, making it highly radioactive. This possibility also makes it essential to provide connections for complete flushing and draining to permit decontamination of the entire unit in the event that it becomes necessary.




*Canned motor pumps are used to satisfy almost identical requirements of this boiling water reactor and conventional high pressure boilers.*

### forced circulation raises reactor output

The original 5-Mw Experimental Boiling Water Reactor (EBWR) at Argonne National Laboratory, employs thermal head to circulate coolant in the reactor. The Arbor Project Reactor of Argonne National Laboratory will use forced circulation to increase output. The 180-Mw Commonwealth Edison and Nuclear Power Group's Dresden plant will be a dual-cycle boiling water reactor with forced circulation through a secondary steam generator, using canned motor pumps. The 66-Mw Northern States Power Company plant will be a Controlled Recirculation Boiling Reactor (CRBR), using multiple forced circulation pumps of a type to be selected.

In boiling reactors, control of circulating flow by pump speed control is highly desirable to avoid dependence on remote-controlled hermetically sealed valves. The variable-flow requirement makes it necessary for the pump to operate from time to time at speeds other

than its best conditions, with increased suction head requirements necessary during these periods. The lower system pressure, preference for double suction, and variable-speed requirements all favor the selection of mechanically sealed pumps. The buffer-seal type appears suitable, or an externally enclosed motor drive can be used, operating in an inert-gas atmosphere above the reactor liquid level. Here, some gas in solution in the coolant can be tolerated.

For condensate and boiler feed-pump service, a combined pump unit was selected in the Argonne Boiling Water Reactor so that only one shaft seal was required. This seal provides for controlled leak-off to a recovery system, with dehydrated air supplied to the seal and flanges to avoid contamination with atmospheric moisture when heavy water is used as a primary coolant.

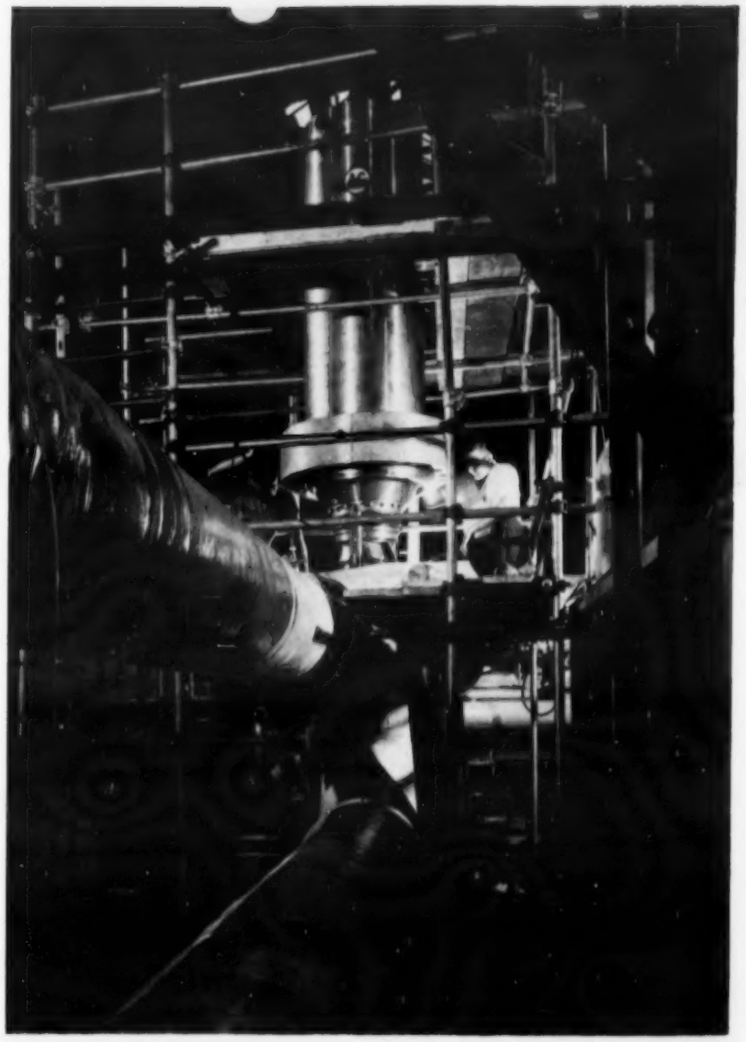
### homogeneous reactors use aqueous solutions or slurries

In the homogeneous reactor developed by Oak Ridge National Laboratory, the fuel is in solution in normal water or heavy water, which acts also as both moderator and coolant for the reactor. As in the pressurized water reactor and boiling water reactor types, a high-pressure level is essential to secure reasonably high water temperature in the reactor. Homogeneous Reactor Experiment No. 1 (HRE-1), 1000-thermal kw, was operated at 1000 psi and used a 150-gpm canned motor fuel solution circulating pump. Homogeneous Reactor Experiment No. 2 (HRE-2), 5000-thermal-kw, operates at 2000 psi, using a 400-gpm canned motor fuel circulating pump. For the third step, designated HRP, a 50-Mw thorium breeder type, a 4000-gpm, 200-ft head canned motor fuel circulating pump is specified. Contracts for 150-Mw plant, the Pennsylvania Advanced Reactor Project (PAR), of the aqueous homogeneous reactor type, have been let by Pennsylvania Power and Light Company. This plant is expected to use an aqueous slurry circulated by four 8000-gpm, 150-ft head canned pumps. The Wolverine Electric Cooperative also has selected an aqueous homogeneous reactor, rated 10 Mw, using uranyl sulphate dissolved in heavy water as fuel, moderator, and coolant. Canned motor pumps are specified for this AEC power demonstration program plant.

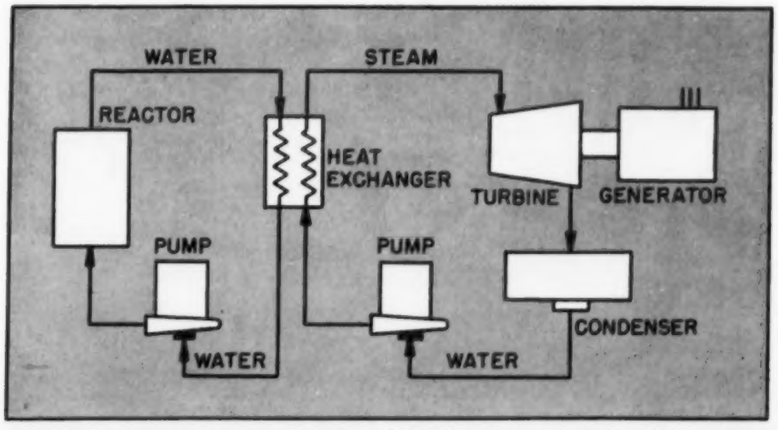
### corrosive fuels require special pumps

The most important special factor affecting pump selection for aqueous homogenous reactors is the highly corrosive nature of fuel solutions at high temperatures. Corrosion is most severe in parts exposed to high liquid velocities, which may limit materials for such parts to titanium, tantalum, tungsten, or even gold and platinum, in solid, clad, or plated form.

Control of homogeneous reactors is claimed to be almost automatic. Demand for increased power causes a pressure drop in the steam generator, which cools the primary fluid. This causes increased density in the reactor, thus increasing the critical mass and output. Similarly, decreased demand takes less heat, increasing fuel solution temperature, which decreases reactor output. Pump flow can therefore be at a uniform rate except during start-up, when low flow is desired for a short time until the system is warmed up. This flow has been secured in the homogeneous reactor experiments by running the circulating pump backward for a five-minute warmup period. This method may be practical for later installations if the specific speed selected is low enough to permit the unit to pump in the same direction with reversed rotation. Control for the circulating pumps is therefore expected to be conventional starting and protection equipment, with the alternate possibility of two-speed motor control or reversing control for the short-time low flow condition.



*PWR pump unit for Shippingport Reactor power plant at Duquesne Light Co., has integral 1500-hp canned motor, handles 18,300 gpm of water.*




*PWR system places heavy loads on both the primary and secondary pumps.*

### liquid-metal coolants show promise

A typical liquid-metal reactor flow diagram is shown on page 27. For the first liquid-metal cooled ship reactor, designated Ship Intermediate Reactor (SIR), an intensive pump development program was carried out, resulting in development of electromagnetic pumps that have proved satisfactory in several variations. Canned motor centrifugal pumps and several special liquid-metal seals for mechanical pumps were also developed. Many difficulties in the circulation and containment of the preferred liquid metals, such as the hazards of self-ignition upon exposure to atmosphere, the generation of explosive gases upon contact with water, solidification upon cooling, plugging from oxygen contamination, mass transfer of materials, self welding of rubbing parts, and sever thermal shock due to high heat transfer rates have been overcome. In spite of these difficulties, use of liquid metals as reactor coolants presents such great advantages that many reactor systems are being developed to utilize them. These advantages

*(continues on page 27)*

*Huge volume of water is returned to the Delaware River in a clean, uncontaminated state. Any oil, entrained in the water from petroleum processes, is removed by oil-field separators before the water is returned to the river.*

**Modern refineries need a dependable water supply to satisfy the almost insatiable appetite of refining processes. Tidewater Oil Company's engineers found that a . . . .**

# Dependable Water Supply gives shutdown insurance

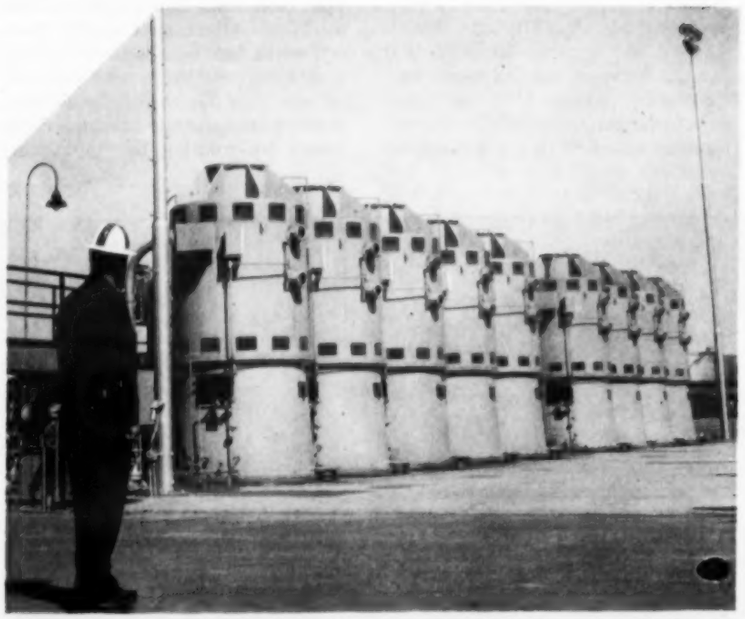
**ROBERT M. HUNT**
Sup't. of Utilities
Tidewater Oil Company

ONE-HALF BILLION gpd water supply system is a key factor in the successful operation of Tidewater Oil Company's refinery. This $200-million refinery has a capacity of 130,000 bbl/day and produces about 10% of all gasoline and other petroleum products used in the Middle Atlantic States.

Water system has to provide a dependable supply for cooling requirements throughout the huge refinery. Dependability is a must, since almost all processes would shut down if the cooling water supply should fail. In addition, discharge water has to be returned to the Delaware River in a clean state to avoid contamination of the river.

All debris and foreign matter is removed from the water prior to reaching pump suctions. Nine Byron Jackson Pumps, Inc. vertical centrifugal pumps were installed to supply the large volume required. Water supply system required the dredging of a 600-foot intake channel 40-feet deep, from the mouth of Cedar Creek to the pump inlets. Water passes through a trash rake before entering six 8-by 8-foot doors on the channel bottom. Water is taken from the channel bottom to assure that the coolest water possible enters system.

First step in water treatment consists of chlorination. Chlorine,



*These nine vertical pumps are the largest of their type ever built. Together, they supply 396 million gpd of water for all the refinery needs.*

*These nine traveling screens remove fish, weeds, sticks, and other debris from influent water to protect the pump impellers from serious damage.*

received in tank-car lots, is piped ¼ mile to the intake site. Water is chlorinated to one ppm residual chlorine to inhibit growth of algae, slime, and barnacles on heat exchanger surfaces.

Water passes through nine traveling screens after chlorination. Screens consist of a moving panel of ¼-inch-opening wire screen, which extends 30 feet below ground level. Each panel is thoroughly washed with a high-pressure hose at the end of its upward travel to remove refuse. All refuse is flushed into a removal trough before basket turns over the head shaft for another trip into influent channel. Screens remove fish, weeds, sticks, and other debris. Screens start and operate automatically.

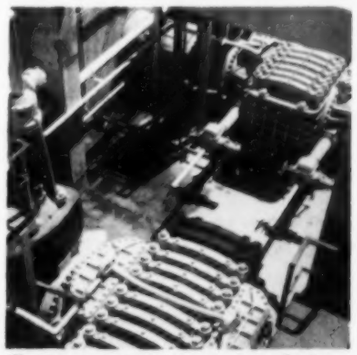
### stainless steel pump parts combat corrosion problems

After chlorination and screening, water enters the nine two-stage vertical centrifugal pumps. Each pump delivers 34,375 gpm at 184-foot head. Pumps are designed to be run backwards if it is desired to drain system. Inlet water to the pumps varies from fresh to brackish. Consequently, pump parts — including impeller, pump cases, shaft, and column — are constructed of stainless steel. Each of the nine pumps is driven by an Allis-Chalmers vertical 2000-hp, 600-rpm, totally enclosed, fan-cooled electric motor.

### independent power feeders insure against failure

The nine motor and pump units are serviced by three independent substations. Power is delivered to each of the three substations by two independent 13,800-volt feeders, each following a widely varying route. Each feeder, from the Delaware Power & Light Co. source, ties into a separate bus in the power station. Every precaution is taken to avoid shutdown of pumps (and refinery) through power source failure.

To prevent explosion hazards from flammable refinery vapors, pump switchgear is installed in a pressurized building. Air is drawn into the building through a duct extending above the roof, where the danger of explosive vapors is reduced. Vapor seal is built into all ducts entering switchgear building to further minimize explosion hazards.



*Contaminants are removed from the water before entering each refining unit by twin-basket strainers.*

Hydraulic, piston-operated butterfly valves, located on pump discharge, act as check valves. They close on power failure to any individual pump. They also double as shutoff valves. By manually varying oil to actuating cylinder, valves can be held in any position.

Each butterfly valve is 36 inches in diameter with 125-lb cast iron body, Ni-resist disc, stainless steel shaft, and silicone-lubricated bronze shaft bearings. Body has reinforced gum rubber insert lines to provide water-tight seating in positive closure.

*Pressurized switchgear buildings. Duct, extending above the roof, in the center of the picture, is the air inlet to the building. The inlet air is obtained from this height to minimize danger of explosion.*

### duplicate water headers give added dependability

Water enters two 78-inch headers after leaving the pumping system. These two headers provide water to all refinery units. Duplicate lines offer safety factor in that failure of one line will not completely sever supply.

Twin-basket strainers are installed at the point where water enters each refining unit. There are 12 pits throughout the plant, one for each refining unit. These strainers remove any remaining contaminants. After water leaves refining units, it passes through a standard oil-field API separator so that water is returned to the river in an uncontaminated state.

One operator per shift takes care of entire cooling-water system. Operator also takes care of the API separators and other stream purification equipment.

The cooling-water pumping system is an ideal installation. It furnishes the huge volume of water needed, with every precaution being taken against refinery shutdown due to pump failure. The nine vertical pumps operate continuously, quietly, and safely. ♦ ♦

*For more information about the principal equipment used in this installation, use the Reader Service Card, pages 3 and 50.*
*Vertical centrifugal pumps; Byron Jackson Pumps, Inc. Circle No. 1333*
*Pump motors; Allis-Chalmers Manufacturing Co., Circle No. 1334*
*Switchgear; Allis-Chalmers Manufacturing Co., Circle No. 1335*
*Transformers; Allis-Chalmers Manufacturing Co., Circle No. 1336*
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NATIONAL AIROIL

# Oil Burners

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Available in three sizes, the NATIONAL AIROIL Dual Stage Burner fires all grades of fuel oil from No. 2 to No. 6, with a ready capacity of 80 to 300 g.p.h. Further, for a perfect flame pattern, we would recommend using with the Dual Stage Burner either the NATIONAL AIROIL Universal Register for forced draft or, the NATIONAL AIROIL Tandem Unit for natural or induced draft furnaces.

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Circle 1124 on Reader Service Card

*Robert R. Braeden, plant engineer, inspects one of several control centers. Compact control panel saves time and gives close control over process.*

# Compact control centers reduce distribution losses

CONCENTRATING ELECTRIC distribution system components and locating recording temperature instruments close to control points provide the answer to accurate process control. Toledo Grocery Products Division of General Mills, Inc., proves this point at their Toledo, Ohio plant.

Incoming Toledo Edison Power Company power feeders are 3-cable, 15-kv, 500-mcm interlocked aluminum-armored cable. Power at 12,470 volts, 3-phase, grounded wye, is delivered to primary switchgear located on mezzanine floor.

Primary switchgear consists of 250-amp main circuit breakers with five secondary circuit breakers (three 100-amp and two 80-amp) leading to five transformers. Two Wagner Electric Company 750-kva, and three 1000-kva liquid-filled transformers reduce voltage to 480 volts for plant use.

From primary switchgear, power is delivered to each transformer by 3-cable, No. 6, 15-kv armored cable. Busway is used from the transformers to the control centers.

Distribution bus carries power through the roof to individual control centers. Nine control centers are located throughout the plant to provide control close to process equipment. All circuit breakers within the motor control centers are by I-T-E Circuit Breaker Company, and motor starters are by Allen Bradley.

Main bus (¼-inch by 2-inch) brings power to control centers where secondary bus (3/16-inch by 2-inch) is tapped in to deliver power to individual control points.

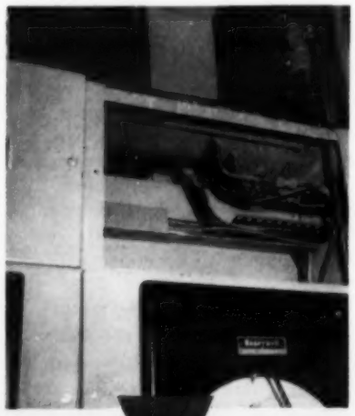
Distribution losses are kept to a minimum by running high-voltage feeders as close as possible to control centers. Busway further reduces losses by providing large-area conductors.

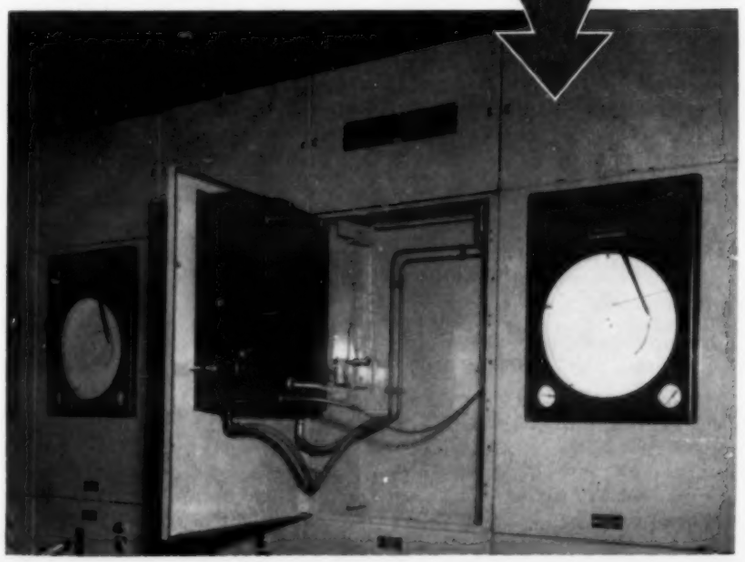
Major innovation in instrumentation was placing Minneapolis-Honeywell Brown Instrument Division temperature recording instruments immediately above (on the same control panel) process control switchgear. Completed panels result in a concentrated control location for all instrumentation and controls.

Continental Electric Equipment Company fabricated the equipment and Rogers Electric Service, Inc., installed the system.

Accurate temperature control, vital in continuous food processes, together with single-location temperature instrumentation and control switchgear are provided in this installation. ♦ ♦

*For more information about compact control centers, circle No. 1330 on Reader Service Card, pages 3 and 50.*





## Performance monitoring

. . . starts on page 11

Some saving in manpower will result from the application of data processing equipment, but there is an inherent limitation as to how far we can go in replacing men with machines. For overall supervision of the generating plant, or for infrequent specialized operations encountered during start-up, emergencies, etc., the judgement and skill of an experienced operator is the most economical device that has yet been invented. As an operator's skill improves, the need for complex machines to take his place diminishes. Man will always be master of the machine.

### will assist overall plant improvement

It is expected that data supplied by analog performance monitoring and digital testing equipment will assist in overall plant improvement in the following ways:

- Data supplied to Management will enable intelligent scheduling of unit shutdowns for maintenance on the most economical basis.
- Data supplied under actual operating conditions will give an accurate knowledge of the various processes involved in the steam-electric generation cycle, and will assist in the design of improved equipment and systems.
- Finally, it is expected that detailed monitoring of the plant under both steady state and dynamic conditions will permit continuous and detailed fault analysis of various elements of the cycle.

In applying performance determination equipment to steam power plants, as in applying data processing to business operations, success or failure depends entirely upon development of proper methods. In the terminology of the computer engineer, this is called programming. Much further study is indicated before we reach the ultimate program for determining steam-electric generator performance, but it is hoped that the performance equipment referred to above will take us another step toward ultimate power plant operation under optimum conditions. ♦ ♦


I-T-E

MOLDED CASE CIRCUIT BREAKERS

**The I-T-E Cordon plug-in circuit breakers** pictured in the control board above distribute current to machines in the Yorklyn, Del., plant of National Vulcanized Fibre Co., world's largest manufacturer of vulcanized fibre.

**"We selected I-T-E breakers** to solve our problem in the manner we desired," says John L. Bahr, chief engineer for National Vulcanized Fibre Co.

## "I-T-E CORDON® Plug-in Breakers Proved the Most Economical and Convenient Way to Meet Our Increased Power Capacity Needs"

"The growth of our company over the years required the addition of a public utilities tie line into our Yorklyn, Del., plant to supplement the plant's generating facilities. This move created two problems: it meant that we would have to substantially increase the maximum potential current interrupting capacity of our control board; and within a limited amount of space available.

"After considering several possibilities, we found that I-T-E Cordon plug-in type circuit breakers would solve both problems. We were able to satisfy our interrupting capacity requirements in the existing control board space. And plug-in features permit taking out any circuit when necessary without shutting down the entire board."

I-T-E Cordon circuit breakers combine the usual thermal magnetic trip unit for protection against overloads with current limiting Amp-traps,* which assume the fault clearing duty when actual short circuits occur. Thus I-T-E Cordon circuit breakers extend the interrupting capacity to 100,000 rms amperes without the necessity of designing special structures for maximum available shorts. Ask your I-T-E representative for complete details or write Small Air Circuit Breaker Division, 19th & Hamilton Streets, Phila. 30, Pa.

**Amp-trap is a registered trademark of the Chase-Shawmut Co.*

I-T-E

SMALL AIR CIRCUIT BREAKER DIVISION

I-T-E CIRCUIT BREAKER COMPANY

19TH AND HAMILTON STREETS, PHILADELPHIA 30, PENNSYLVANIA

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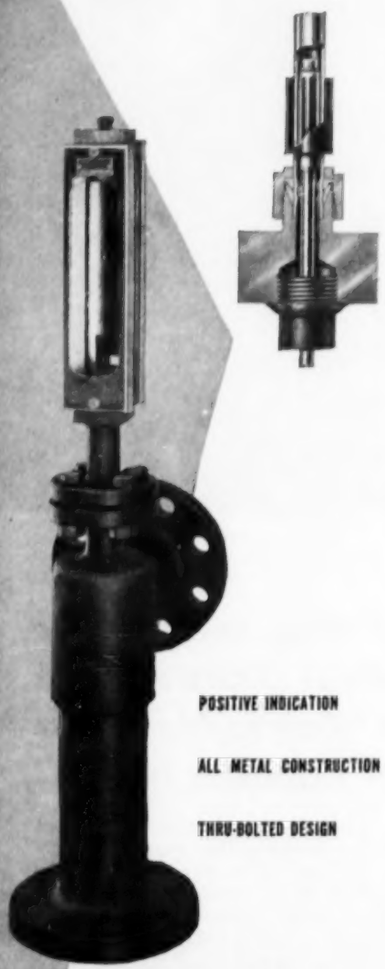


Working with highly penetrable fluids . . . high temperatures, high pressures? Then, Brooks Ar-Met Rotameters are made to order for you.

The Brooks Ar-Met Rotameter with Mag/Na/Vue indicating extension is shown . . . however, Ar-Met meters are also available with six other alarm and transmission extensions, both electrical and pneumatic. WRITE FOR BULLETIN 13'

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Two standard techniques for

# Insulating Expansion Joints

FOR MAXIMUM thermal efficiency, an insulating barrier must cover heated equipment completely. On regular, uninterrupted stationary surfaces this is a relatively simple problem with a straightforward solution. The insulating material, regularly shaped, is simply fastened mechanically to the hot surface in a normal manner.

Surface irregularities complicate the problem because they call for an interruption in the basic insulating layer and some sort of special insulation treatment. Duct flanges and stiffeners are examples. They must be insulated because although their surface area may seem small in comparison to the overall duct area, it is significant when considered in terms of total heat loss potential. However, flanges and stiffeners, although requiring special treatment, are not especially difficult to insulate. They usually require only that the insulating material be built out around them to provide complete coverage.

Duct expansion joints are another story. Here the successful application of insulation requires more than just covering the joint area with a sufficient thickness of insulating material. The insulation must be secured in such a manner as to allow the joint to function properly — to move — without being damaged.

There are two approaches to insulating an expansion joint so that it will function properly with the insulation intact. One is to use a material sufficiently flexible to adjust itself to the movement of the joint. The other is to use rigid insulation constructed in two separate sections, which permits relative movement.

### amount of expansion influences method

The amount of expansion a joint is expected to accommodate will influence the choice of method, as will the materials and techniques used to insulate the ducts themselves. Using same type insulation and attachment methods as used to insulate flat duct surfaces will simplify construction.

Both types of expansion joint insulation treatment were specified by Combustion Engineering, Inc., in insulating ductwork associated with the two new 560,000 lb/hr boilers recently erected at Taconite Harbor, Minn. for Erie Mining Co.

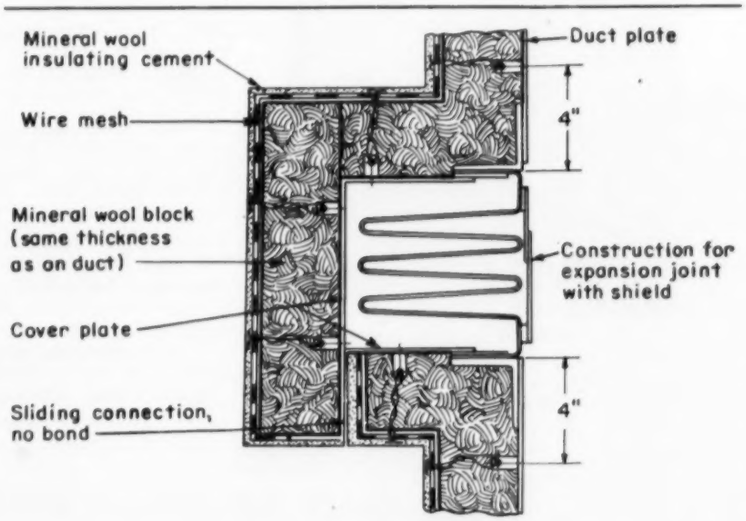
Mono-Block, a mineral wool insulating block manufactured by the Baldwin-Hill Co., Trenton, N. J., was used to cover the ducts and accessory housings. Lightweight and resilient, it is easy to cut and shape to conform to surface irregularities. It is easy to apply. Finish consisted of Baldwin-Hill No. 1 Insulating Cement reinforced by wire mesh.

Flanges and stiffeners were insulated with built-up sections of block and by half-sections of molded mineral wool pipe insulation.

At expansion joints, using same basic attachment methods helped to standardize methods. However, some additional materials were required.

Duct expansion joints at Taconite Harbor were insulated with either rigid or flexible insulations depending upon their movement. For joints with relatively little movement (up to 3-in) flexible insulation was used. For joints with greater expansion, the insulation was constructed of rigid material in two separate independent sections capable of moving with respect to each other.

Designed for a 1000 F superheat temperature and operating at a design pressure of 1657 psi, each of the two large steam generating units will power a 67,500 kw turbo generator. Plant will not only supply power for the mining company's port operations at Taconite Harbor, but for its mining and refining operations nearly 80 miles inland, as well. ♦ ♦

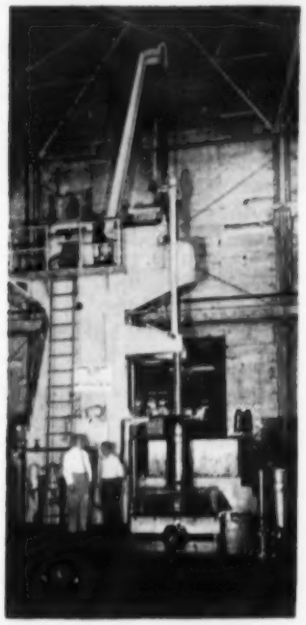



SECTION AT SAWTOOTH EXPANSION JOINT

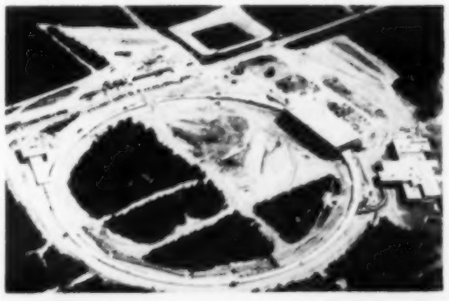
*For more information about Flexible Insulation circle 1328 on Reader Service Card, pages 3 and 50.*

# Photo News

◀ POWDER-LANCING process speeds demolition job at GE's new radiation lab, Schnectady, N.Y. Above, powder-lance in action. Right photo shows huge slab cut and ready for disposal. ▶

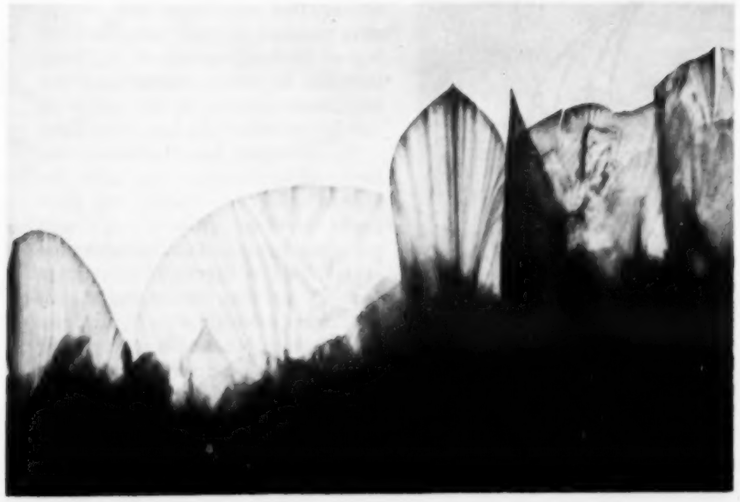


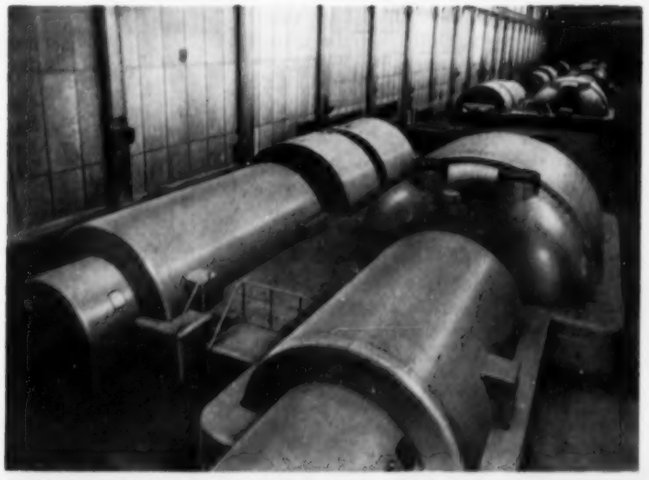
◀ GIANT vertical honing machine goes to work at Cooper-Bessemer's Grove City, Pa., plant. Machine hones large cylinder liners for gas, diesel, and gas-diesel engines.



◀ RACETRACK will house magnet assembly for world's most powerful proton accelerator now under construction at Brookhaven National Laboratory, Upton, N.Y.

WHAT IS IT? Crystals, magnified 9000 times, erupt from surface of stainless steel under corrosion study at Westinghouse Research Laboratories. Engineers say crystals may cause type of metal failure called stress-corrosion cracking. ▼





◀ FOURTH CLOSE-COUPLED, cross-compound steam turbogenerator goes on line at Wisconsin Electric Power Company's Oak Creek plant. These two 120,000-kw and two 130,000-kw units, all by Allis-Chalmers, give plant total generating capacity of 500,000 kw, largest in Wisconsin.

POWER BASICS FOR TODAY'S INDUSTRY

## Fluid mechanics – V

# Turbulent conduit flow

**This part of the fluid mechanics series deals with the aspects that most readers will encounter in their daily work — the effect of valve throttling action, head loss due to friction, etc. Brush up your fluid mechanics now — tomorrow, you may be glad that you did.**

**JAMES M. ROBERTSON**
Professor of Theoretical and Applied Mechanics
University of Illinois

MOST OF OUR problems and experiences in conduit flow involve turbulent flow. From an analytical standpoint this is sad. Our treatment of turbulent flow is semi-empirical and phenomenological at best, rather than well-founded on physical theory, as in the case of laminar-viscous flow. The best we can do is to make our approach rational and logical, utilizing similarity considerations to the utmost, to maintain generality.

### turbulent flow velocity varies with time

In a turbulently flowing fluid, velocity at any point varies in magnitude and direction with time. The magnitude of the fluctuation depends upon strength of the turbulence at that point. Turbulence is conceived as being a collection of eddies moving about amongst each other in a random fashion while being carried along by the mean flow. To have a single quantity that we can discuss and use, we average the fluctuating velocity over a short time period. This average or mean velocity (which we will simply call velocity hereafter) varies across the flow, but not at the same rate as velocity does in laminar-viscous flow. Near the wall, the velocity gradient for pipe flow is very steep, while away from the wall it becomes rather flat (fig. 1).

In fully developed pipe flow, the shear stress varies linearly from the wall value $\tau_w$ to zero at the center. In turbulent flow, we have no unique relationship between shear stress and velocity gradient, so we cannot simply solve for velocity distribution. Some progress has been made with the help of the Prandtl mixing length concept, which leads to the relationship:

$$\tau = \rho l^2 \left(\frac{du}{dy}\right)^2$$

Mixing length l gives an indication of the size of our imaginary eddies. Using several rather crude assumptions, the mixing length approach leads to quite satisfactory relationships for velocity distribution near a surface or wall and at some distance away. The near-wall relationship is often considered to be a universal one, applying from near the wall to pipe centerline:

$$u = A + B \log y$$

Constants A and B depend upon wall friction and must be evaluated empirically.

For flow along a smooth wall, the logarithmic velocity law just indicated does not apply right up to the wall. Turbulence results (or, at least, we conceive that it does) from inertia forces in the flow overcoming the stabilizing effect of the viscous forces. Near a wall, the inertia forces decrease in relation to the viscous forces, so we postulate that a thin laminar film of fluid occurs at the wall. Existence of this laminar film is well established experimentally and is most helpful in explaining the action of rough surfaces. When a surface is acting hydraulically rough, we find that the constants in the logarithmic velocity law noted above depend upon size of the roughness. However, we find that under certain flow conditions (low Reynolds number) a mechanically rough surface will behave as though it were hydraulically smooth in terms of the laminar film. This behavior is easily explained.

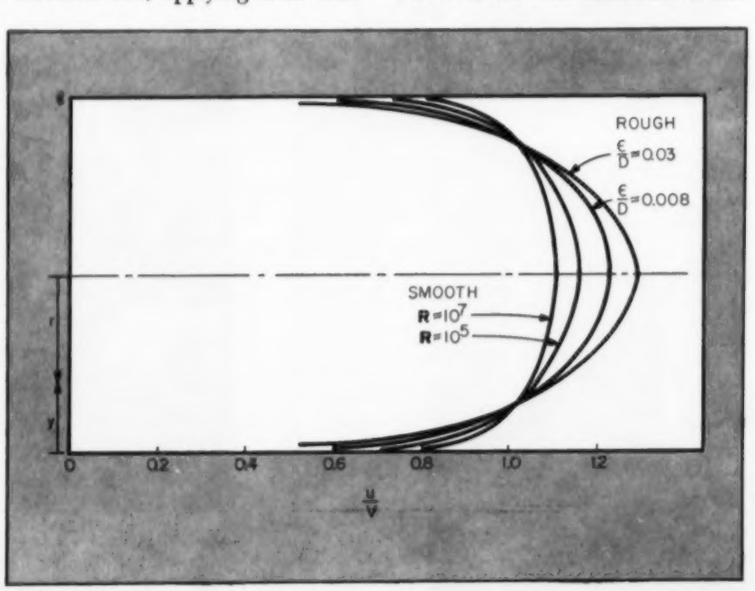



*Fig. 1 – Turbulent velocity profiles indicate that near wall, velocity gradient for pipe flow is very steep, but away from wall, it becomes rather flat.*

Thickness of the laminar film, separating the turbulent flow from the wall past which it is moving, decreases as the Reynolds number increases. At low Reynolds numbers, the film is relatively thick and a certain height of roughness is completely submerged within it. Under this condition, the roughness appears to have no effect. At higher Reynolds numbers, the laminar film is much thinner and the roughness projects through it enough to affect the turbulent flow.

To illustrate how turbulent velocity distribution in fully developed pipe flow varies with Reynolds number ($R = VD/\nu$) and pipe roughness, let us consider pipe factor. This is the ratio of average velocity of flow to centerline or maximum velocity, $P = V/u_c$. Similarity consideration suggest that we represent pipe roughness as the dimensionless relative roughness factor $\epsilon/D$, where $\epsilon$ is the roughness height. Based primarily on some experimental studies with an artificial roughness, the variation in

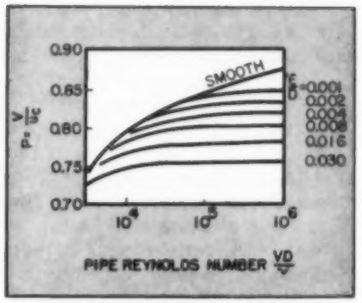



*Fig. 2 – Pipe factor varies with regard to $\epsilon/D$ and Reynolds number.*

pipe factor with $\epsilon/D$ and Reynolds number is as indicated in fig. 2. The rough pipe lines join with the smooth line at low Reynolds numbers, which indicates a rough surface acting hydraulically smooth. It should be noted that beside being a simple indicator of the nature of velocity distribution, pipe factor is of some value in rate of flow measurements. If P is known, one need only measure velocity at the center of the pipe to evaluate discharge velocity V and hence rate of flow. In studying fig. 2, it should be recalled that in laminar flow (Reynolds numbers below 2000 to 2500) the pipe factor is one-half.

### head loss due to pipe friction

Our most pressing problem in conduit flow is often that of calculating head loss due to friction. A rational expression for this head loss utilizes the friction factor:

$$h_f = f\frac{L}{D}\times\frac{V^2}{2g} \qquad (1)$$

This is strictly applicable only in fully developed flow, which occurs at some distance from disturbing influences such as valves, bends, entrances, etc. For pipe acting fully rough (roughnesses projecting through laminar film) the friction factor is a unique function of the relative roughness. For smooth pipe, f is a function of the pipe Reynolds number. The general manner in which f varies with Reynolds number and pipe roughness is indicated in fig. 3. By using charts such as this, the problem of determining friction head loss is reduced to one of estimating absolute roughness of the pipe wall. This is a function of the pipe material and its fabrication. Some values are given in fig. 4.

EXAMPLE: Fuel oil ($S = 0.88$, $\mu = 4\times10^{-5}$ lb-sec/ft$^2$) is being pumped through 3-in. steel pipe with a velocity of 6 ft/sec. What is head loss per 100 feet of the pipeline?

SOLUTION: Density of oil is $\rho = 0.88\times62.4/32.2 = 1.71$ slugs/ft$^3$, and the velocity head is $V^2/2g = 36/64.4 = 0.56$ ft. From fig. 4 or a similar presentation of pipe roughness, $\epsilon = 0.00015$ ft or 0.0018 in. Therefore, relative roughness is $\epsilon/D = 0.0018/3 = 0.0006$. Reynolds number is:

$$\mathbf{R} = \frac{VD\rho}{\nu} = \frac{6\times0.25\times1.71}{4\times10^{-5}} = 6.4\times10^4$$

From a friction factor presentation such as fig. 3, $f = 0.027$. Head loss is therefore:

$$h_f = f\frac{L}{D}\times\frac{V^2}{2g} = 0.027\times\frac{100}{0.25}\times0.56 = 6 \text{ ft}$$

This answer is in feet of fluid flowing – in this case, feet of fuel oil. Expressed as a pressure it is

$\Delta p = \gamma h_f = 0.88\times62.4\times6$
$= 330$ lbs/ft$^2$ or 2.3 psi.

When turbulent flow in a noncircular conduit is encountered, the hydraulic radius approach is used. With this, it is assumed that friction loss is the same if four times the hydraulic radius (flow area divided by wetted perimeter) is used instead of the diameter in eq. 1, in Reynolds number, and in the relative roughness. This method has been well verified experimentally for turbulent (but not for laminar) flows.

EXAMPLE: What is the loss in 120 feet of 4 by 11-in. air duct carrying 200 ft$^3$/min of air?

SOLUTION: We shall assume that the air is at standard conditions for which specific weight $\gamma = 0.076$ lbs/ft$^3$ and the viscosity $\nu = 1.4\times10^{-4}$ ft$^2$/sec. We shall assume that the roughness of the duct is equivalent to that of a galvanized iron pipe, $\epsilon = 0.0005$ ft or 0.006 in. We calculate velocity of flow to be 10.9 ft/sec and the velocity head $V^2/2g = 1.85$ ft. Equivalent diameter (four times hydraulic radius) is:

$$D = 4\frac{\text{area}}{\text{perimeter}} = 4\frac{4\times11}{30} = 5.87 \text{ in. or } 0.49 \text{ ft}$$

therefore:

$$\frac{\epsilon}{D} = \frac{0.006}{5.87} = 0.001$$

$$\mathbf{R} = \frac{VD}{\nu} = \frac{10.9\times0.49}{1.4\times10^{-4}} = 3.8\times10^4$$

From a chart similar to fig. 3, we find $f = 0.027$. Head loss is:

$$h_f = f\frac{L}{D}\times\frac{V^2}{2g} = 0.027\frac{120}{0.49}1.85 = 12.3 \text{ ft of air}$$

As a pressure drop this is:

$\Delta p = 0.076\times12.3$
$= 0.93$ lbs/ft$^2$

With air flows, pressures are often indicated in inches of water. In this case, the loss is $0.93\times12/62.4 = 0.18$ inches of water.

Besides its use in evaluating losses in ducts and other noncircular conduits, the hydraulic radius approach is universally used in analyzing the uniform flow of liquids in open channels. For channels made of the materials listed in fig. 4, solving the relationship between channel slope, depth of flow, and discharge is simple and direct. Roughness values for other wall materials are available, but in general they are in terms of other, less universal but more commonly employed, analysis methods such as the common Mannings formula. These other methods are, however, beyond our present discussion.

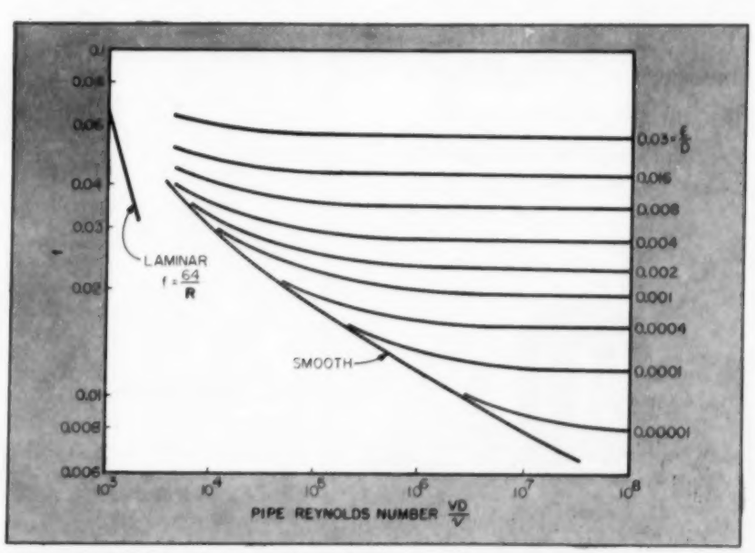



*Fig. 3 – Friction factor varies with Reynolds number and pipe roughness. Such charts are used to simplify determination of friction head loss.*

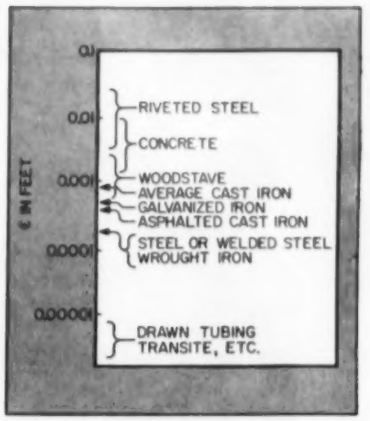



*Fig. 4 – Some values of pipe wall roughness, dependent on material.*

### minor losses must be considered, too

In general, friction losses (resulting from shear stress of the fluid on the pipe wall) are the principal losses occuring in conduit flow. But they are not the only losses, and we often have also to consider the so-called minor losses. These are those due to bends, expansions, valves, entrances, and exits from conduits. They are termed minor because in most cases they produce only a small fraction of the total loss in the conduit.

Minor losses are evaluated generally in terms of the expression:

$$h_L = K\frac{V^2}{2g} \qquad (2)$$

For most elements in turbulent flow, loss coefficient K is a function only of the proportions of the element causing the loss. The numerical value of this coefficient depends upon how much the flow is disturbed. Thus, for an open globe valve $K = 10$, and for an open gate valve $K =$ 0.1 to 0.2. For an elbow, the loss coefficient varies from 0.2 to over 1, depending upon the bend's relative curvature. At the entrance to a conduit, loss coefficient depends upon the rounding of the corner, being 0.5 for a sharp corner and perhaps 0.05 for a rounded one. At an exit into a large container, one velocity head is lost and $K_{exit}$ is therefore 1.0.

An expansion is one element for which eq. 2 does not properly

*(continues on page 29)*

# How to tame a dust collection problem

Look for the 'hidden' factors that deliver important *extra efficiency*, like the exclusive Shave-off in Buell Cyclones that harnesses the double-eddy currents to trap an extra percentage of dust. Side-entry of gases, Buell-designed manifolds, proper proportioning, extra-heavy-plate construction provide even more efficiency. Send for the ready reference booklet, "The Collection and Recovery of Industrial Dusts". Dept. 90-L Buell Engineering Company, Inc., 123 William Street, New York 38, N. Y.

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**DUST COLLECTION SYSTEMS**

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## Steam turbines

. . . starts on page 12

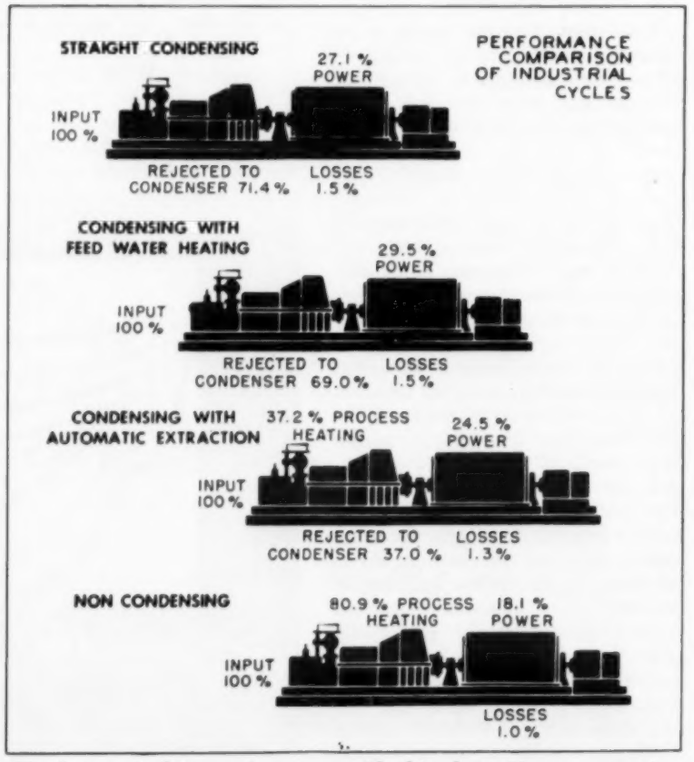
are available with as many as five extraction points depending upon size of the unit.

A related turbine, the so-called mixed-pressure or induction turbine, is also used in industrial cycles. This unit provides for the use of high-pressure and low-pressure steam in proportion to the available supply. Low-pressure steam enters and joins high-pressure steam after the latter has expanded to the pressure at which the low-pressure steam is ordinarily received. The simplest extraction cycle is the condensing, non-automatic extraction or bleed cycle. Here, steam is bled from the turbine at various points and pressure at the bleed points is not controlled.

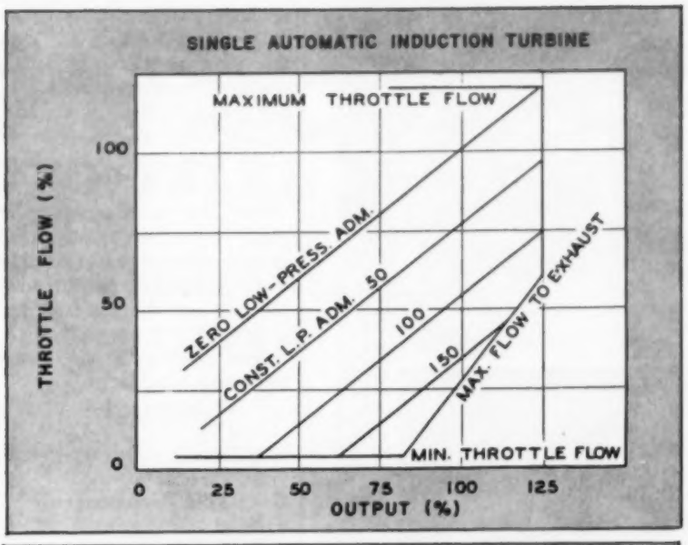
Turbine stage pressures increase or decrease with the amount of steam passing through the turbine. Thus, the bleed pressure at any fixed point will increase or decrease with steam flow or load. This type of cycle finds its use primarily in plants where electric power generation is the prime function. Most frequently used extraction cycle is the single or double automatic extraction condensing cycle. In this cycle, controlled quantities of steam are extracted at one or two points from the turbine at controlled pressures, and the extracted steam is used for process. Pressure of extracted steam is held constant and does not vary with turbine load output. Pressure of extracted steam is controlled by an automatic valve inside the turbine just below the extraction point.

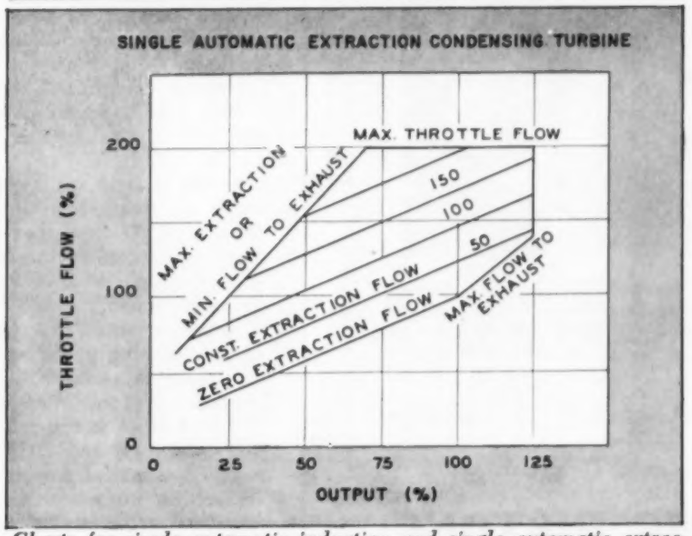
### moderate power demand large steam demand

Automatic-extraction condensing cycle is used in industrial plants when there is a moderate demand for power and a relatively large demand for process steam. This cycle gives low-cost power from the steam required for process. Demand on these units differs considerably from that on corresponding central station units. The variety of possible turbine designs is enormous, owing to the differences in initial steam conditions, relative quantity of power and process steam required, and differences in requirements as to constancy of turbine speed and of




*Check your turbine performance with this chart. If your operation approximates these values above, you have made a good selection.*




*Charts for single automatic induction and single automatic extraction condensing turbines give opportunity to compare performance from maximum throttle to maximum flow to exhaust conditions.*

process steam pressure needed.

### non-condensing-extraction cycle explained

Automatic-extraction non-condensing cycle is perhaps the most versatile industrial power cycle. This cycle differs from the automatic-extraction condensing cycle only in that turbine exhaust steam does not go to a condenser, but is used for driving lower pressure prime movers or for low-pressure industrial process. This cycle has been widely used in various chemical process industries and in the paper industry. With double extraction and non-condensing exhaust, three process pressures are available. This cycle lends itself very well to an existing system that needs additional steam because of increased process and power demands. In this cycle, no steam goes to a condenser. All steam flow through the turbine is used in process. This cycle is not penalized by heat lost to condenser circulating water. Thus, power is produced at the very lowest cost.

### comparison of various industrial cycles

When steam is required in sizeable quantities for heating or for processing, electric power usually can be generated more cheaply than it can be purchased. After considering all the various industrial power cycles, the logical question of which cycle to use must be answered. To arrive at an answer, basic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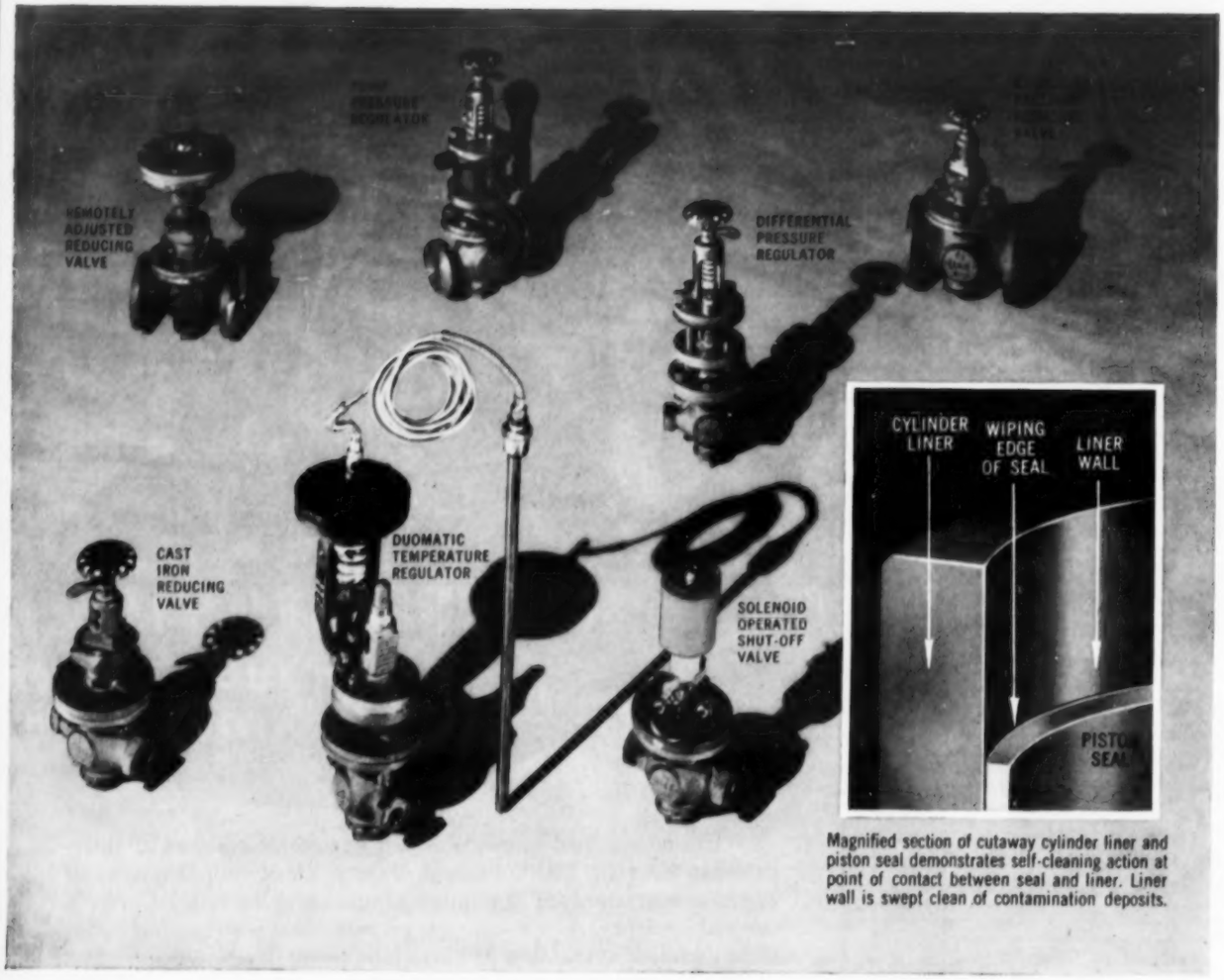

Magnified section of cutaway cylinder liner and piston seal demonstrates self-cleaning action at point of contact between seal and liner. Liner wall is swept clean of contamination deposits.

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analysis and evaluation of reliability and suitability of operation must be made. In addition, the basic cost economics involving capital expenditure and operating costs must be evaluated.

To have some basic comparison between the various types of cycles, we have compared the straight condensing, the uncontrolled extraction-condensing, the controlled extraction-condensing and the non-condensing cycles.

The diagram is based on the following conditions:

Inlet Steam – 400 psig and 750 F.T.T.
Exhaust, condensing – 28½-in. vacuum
Exhaust, non-condensing – 5 psig
Electric load – 5000 kw
Extraction Steam – 50% throttle flow
Extraction Pressure – 5 psig

For 100% heat input to all the cycles shown, the following should be noted:

- For the straight condensing cycle, no steam is available for process, 71.4% of the heat input is rejected to the condenser, and 27.1% is realized as useful power.
- For the uncontrolled extraction-condensing cycle, again no steam is available for process, but only 69.0% of the heat input is rejected to the condenser, and 29.5% is realized as useful power.
- Where no process steam is required and only electric power is needed, the uncontrolled extraction-condensing cycle with feedwater heating is the more efficient cycle.
- In the controlled extraction condensing cycle, 37.2% of the available heat goes to process steam, 24.5% goes to power, and only 37% is rejected to the condenser. This cycle adequately and efficiently fulfills the demand for both electric power and process steam.
- In the non-condensing cycle, 80.9% of the available heat goes to process, 18.1% goes to power. This cycle fulfills the demand for large quantities of process steam in relation to the electric power demand. ♦ ♦

*For more information about Steam Turbines, circle 1331 on Reader Service Card, facing pages 3 and 50.*

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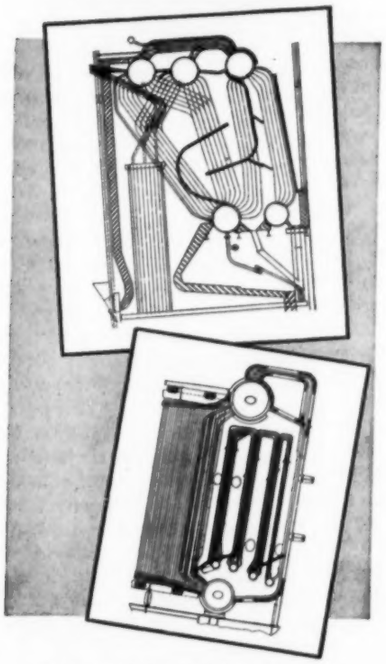

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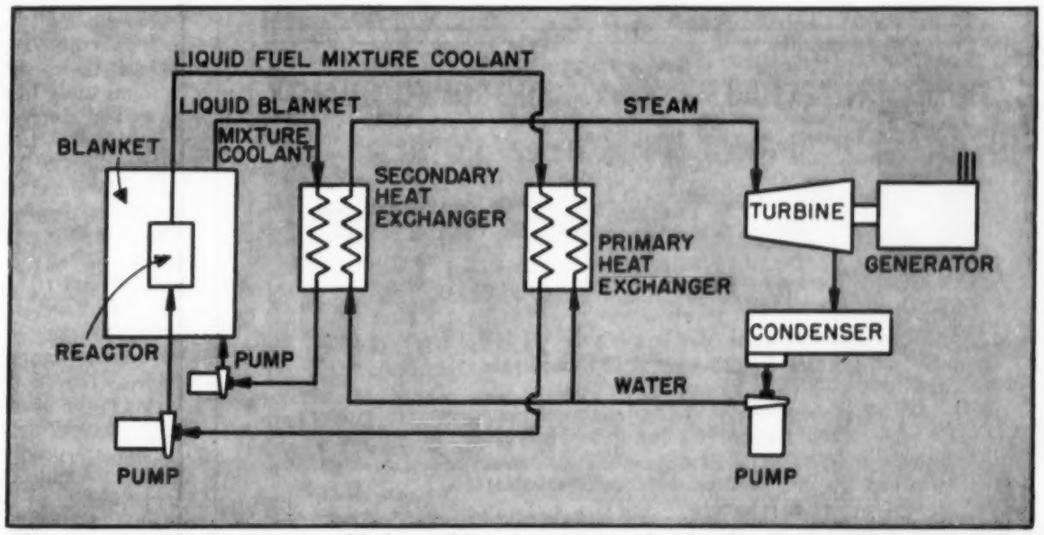
## Nuclear pumps

. . . starts on page 14

include high heat transfer rates, low vapor pressures at high temperatures, low pumping power for the lighter metals such as sodium, potassium, and lithium, low capture of neutrons, and relatively low corrosiveness with preferred construction materials.



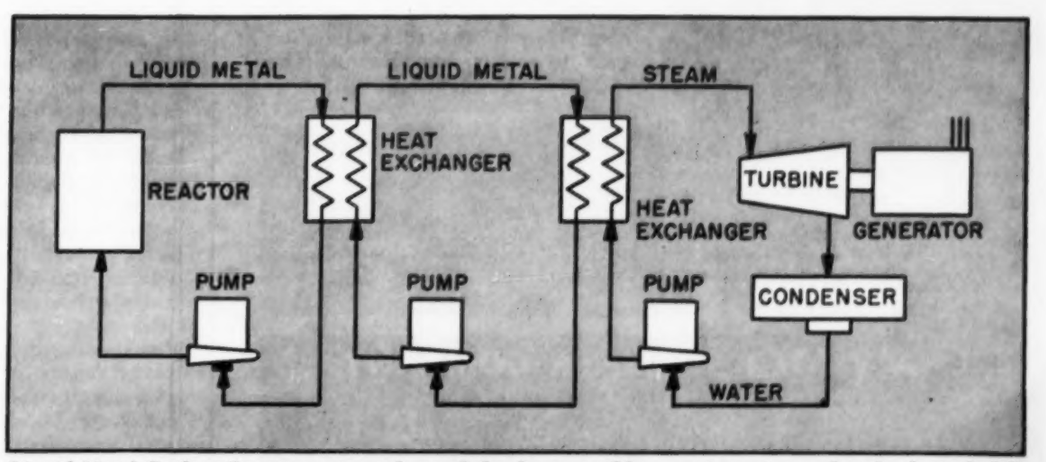

*Homogeneous Reactor systems add the problem of erosion to the already severe problem of corrosion.*

The first experimental breeder reactor used sodium-potassium alloy, NaK, as a coolant in both primary and secondary circuits, while EBR II will use sodium in both circuits, with pumps rated approximately 6000 gpm at 160-ft head, 700 F. The 100-Mw Power Reactor Development Co.'s Enrico Fermi plant will also be a fast breeder reactor, liquid-metal-cooled type, using three 11,800-gpm, 310-ft head sodium pumps in the primary circuit and three 11,800-gpm, 60-ft head sodium pumps in the secondary circuit.

Because of their inherent nature, fast breeder reactors must be designed to prevent loss of coolant, which could result in meltdown of the core into a supercritical mass. These reactors must also be designed to prevent any moderator-type materials, such as oil or water, from entering the system. These could increase the reactivity beyond safe limits. For these reasons, the primary coolant pumps and piping are usually contained within secondary enclosures so that a leak would not cause excessive loss of sodium. The system design also should provide sufficient natural convection circulation for removal of decay heat emitted after shutdown.

### research investigates fast reactors

Research for future fast reactors is being carried out in two configurations by Argonne National Laboratory, in their zero power reactors ZPR III at Arco, Idaho, and ZPR V, a combined fast and thermal neutron reactor. A three-phase program is planned at Los Alamos Scientific Laboratory, the first step of which is the 1000-kw Los Alamos Molten Plutonium Reactor Experiment (LAMPRE-1). This unit will use molten plutonium as the reactor fuel,

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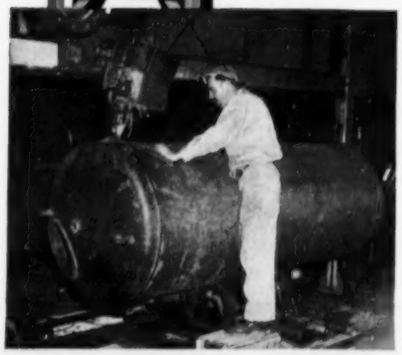

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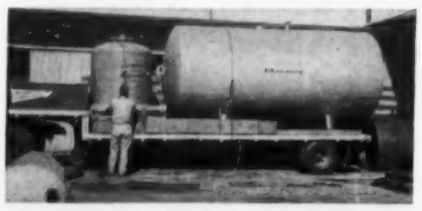

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permitting continuous removal of fission products. Sodium at 1000 F is the coolant. Pumps for this reactor have not yet been selected.

When canned motor pumps are used for low melting point metals, such as sodium without fuel in solution, it is possible for liquid sodium to surround the motor rotor and lubricate the bearings by maintaining the liquid in that area at relatively low temperature (250 F). Since oxides are precipitated in this cool zone, a filtration bypass circuit is required to avoid build-up of these solids. However, systems using bismuth-fuel solutions and slurry must be maintained at a temperature well above the 520 F melting point, and the fused salts at similar or higher temperature levels, to avoid freezing at the coldest zones. It also is desirable to avoid mass transfer of fuel to the cold zones by operating all parts of these circuits at as nearly uniform temperatures as possible. An additional complication exists in the bismuth circuits because a very active poison, polonium, is produced when bismuth is subjected to neutron radiation. The selection of pumps for these circuits must take into account all these factors. Mechanical seals should not be depended upon to maintain the inert-gas atmosphere for such service. Seal lubrication is difficult or impossible. The temperature and contamination conditions are such that the unpredictable service life of mechanical seals could cause extensive shutdowns and highly dangerous personnel hazards.

### sealed pumps maintain gas atmosphere

Two types of hermetically sealed pumps have been developed to maintain an inert-gas atmosphere above high-temperature liquid metals. One type is essentially a canned motor unit with the stator can containing a gas in the motor rotor space. In this unit, liquid level is maintained in a narrow annulus around the shaft between pump and motor rotor. The other type utilizes the external enclosure of a totally enclosed fan-cooled motor to contain inert gas above the liquid, which is held at a preferred level in a sump tank above the pump casing. This design permits the application of developed and tested pumps and motors to assure selection of the most suitable unit for each specific application without duplicating basic development and tooling.

### how to control liquid-metal flow

Control of the liquid-metal fueled reactor will probably require variable flow without using throttle valves in the bismuth-fuel circuit. Variable flow can be accomplished by providing a variable-frequency power supply for the required range. A suitable power supply may be comprised of an ac motor driving an ac generator through a suitable variable speed device such as an eddy-current clutch. For wider speed range, a frequency converter with auxiliary dc-motor drive may be used. Control of the pumps in the other three circuits is expected to be conventional, with a possible requirement for two-speed motor drives. Canned motor, electromagnetic, buffer-sealed, and hermetically sealed gas-filled pumps, with suitable drives, power supplies, and controls are available for all current reactor plants.

Engineers and research scientists are continually working on development of pumps for nuclear reactors. Pump development is keeping pace with the growing variety of nuclear power facilities. ♦ ♦

*For more information about Nuclear Pumps and Motors, circle 1332 on Reader Service Card, pages 3 and 50.*


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## Fluid mechanics

. . . starts on page 22

represent the loss relationship. For the sudden expansion, loss

$$h_L = \frac{(V_1 - V_2)^2}{2g} \qquad (3)$$

where $V_1$ is mean velocity in the approach pipe and $V_2$ that in the following pipe. This is the one and only case in fluid mechanics in which one takes the difference of two velocities and then squares the result, rather than taking the difference of two velocity heads. In the case of a gradual diffuser, the loss may be only 15% of that given by eq. 3 if a small diffusion angle (six to eight degrees) is used. For wider diffusion angles the loss increases and for a cone angle of about 60 degrees, the loss is significantly greater than that in a sudden expansion (diffuser of 180 degrees). The exit loss situation mentioned in the previous paragraph is just a special case of eq. 3 with $V_2$ equal to zero.

An alternative method of treating minor losses is sometimes employed because of the ease with which these can then be combined with the pipe friction losses. Procedure is to replace the device causing the loss by a length of pipe which will produce the same loss. Equating the loss from eq. 2 to that from eq. 1, we find for the equivalent length (expressed non dimensionally) the relationship L/D = K/f. The answer appears to depend upon what pipe we have in mind and the Reynolds number. Friction factor varies with these factors and we usually assume that K does not vary, although there is conflicting evidence in this regard. The precision of our calculations and the information upon which they are based is usually such that this variation need not concern us. If we take f = 0.027 as a reasonable nominal value, the equivalent length of an open globe valve is about 370 diameters while that of an open gate valve is 3 to 8.

EXAMPLE: A small heating and cooling system requires a water flow of 10 gpm through a circuit consisting of 150 ft of 1-in. copper tubing, two open gate valves, six 45° ells, twelve 90° ells, and 24 special diversion tee fittings. In order to choose the proper pump, determine what head loss will be.

SOLUTION: Total equivalent length of pipe is calculated from information about the equivalent length of the various fittings.

| Fitting | Eq. L/D | Eq. L feet | No. | Ft. of Pipe |
|---|---|---|---|---|
| 1-in. copper pipe | | | 150 | 150 |
| open gate valves | 7 | 1 | 2 | 2 |
| 45° ell | 18 | 1.5 | 6 | 9 |
| 90° ell | 24 | 2 | 12 | 24 |
| sp. div. tee | 15½ | 13 | 24 | 312 |
| | | | Total = | 497 |

At 10 gpm, velocity of flow in the 1-in. pipe is 4 fps and velocity head is 0.26 feet. The lowest Reynolds number occurs when system is being used for cooling. Under this condition the water may be as cold as 40 F, for which $\nu = 1.7 \times 10^{-5}$ ft²/sec. Reynolds number is therefore:

$$\mathbf{R} = \frac{VD}{\nu} = \frac{4 \times 1/12}{1.7 \times 10^{-5}} = 1.9 \times 10^4$$

The copper tubing is essentially smooth ($\epsilon/D = 0.00006$) and friction factor is found to be about 0.026. Head loss is therefore:

$$h_L = f \frac{L}{D} \times \frac{V^2}{2g} = 0.026 \times \frac{497}{1/12} \times 0.26 = 40 \text{ ft}$$

When this system is being used for heating, the water temperature will be about 200 F, for which $\nu = 0.33 \times 10^{-5}$ ft²/sec and $\mathbf{R} = 9.8 \times 10^4$. Friction factor is then about 0.018 and head loss for our flow will be reduced by nearly 40%.

### what is valve throttling action?

We have listed valves as minor loss elements, and given their K values when open. Consideration of a valve in a pipe line, whether it be wide open or otherwise, indicates that it acts as a source of head loss. And yet, when we use a valve as a throttle or flow rate controller in a pipe, we tend to think of it acting to cut down the area through which flow occurs. Actually, a valve throttles the flow by acting as a variable resistance. As we close it, all we do is to increase the value of K in eq. 2. When the valve is shut, K is infinity – unless it leaks. If we consider the simple analogy between water flow in a pipe line and electric current flow in a wire, our valve is analogous to


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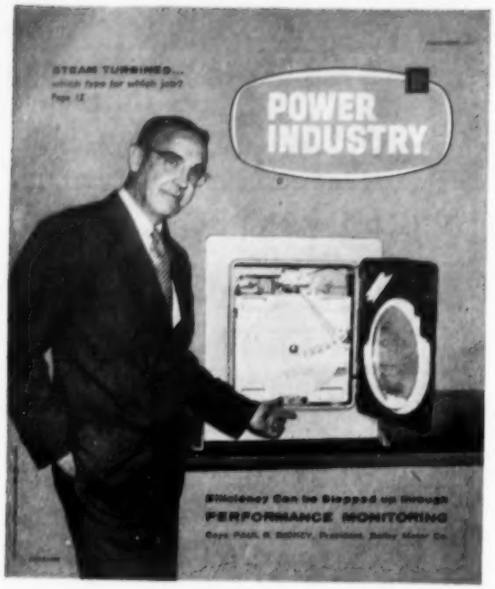


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## Fluid mechanics

. . . starts on page 22

a variable resistance.

It is important that we clearly understand the true nature of valve action. Thus, the erroneous concept of its effect being due simply to the area reduction would lead one to expect a linear relationship to exist between the flow reduction and the decrease in flow area as the valve is shut. Actually, the relationship is quite non-linear, which makes it difficult to predict. Most of our knowledge of the throttling or control action of valves thus comes from experiment. Another situation inadequately explained by the area concept is the interrelationship between several valves in the same pipe line. Instead of flow rate being fixed by the smallest valve opening, independent of the setting of other valves, it depends upon the setting of all valves. The effect of several valves is that their resistances combine to limit flow.

Before considering an illustrative example, let us look at the configuration of some common valves to see how they affect the flow and cause losses. Fig. 5 presents sectional drawings of a globe and a gate valve. In the globe valve, we see that the fluid flowing through it must first turn, then contract and expand, and then turn again. Even when open, the contortions that the fluid must follow obviously lead to high losses. The throttling action of the partly open valve results from a further constriction of flow area and leads to losses upon re-expansion of the flow. Throttling action of the gate valve is also a constriction of flow with subsequent high losses upon re-expansion, as indicated by eq. 3. From fig. 5 it is apparent that when fully open, a gate valve hardly disturbs the flow at all, as evidenced by its very low K value (0.2 or less).

EXAMPLE: Water discharges from a reservoir through 100 feet of 6-in. cast iron pipe under a head of 5 feet. A gate valve is used to regulate the flow rate. The entrance is sharp and the pipe discharges freely to atmosphere. What is the relationship between valve setting, as indicated by handle turns or stem rise, and discharge rate?

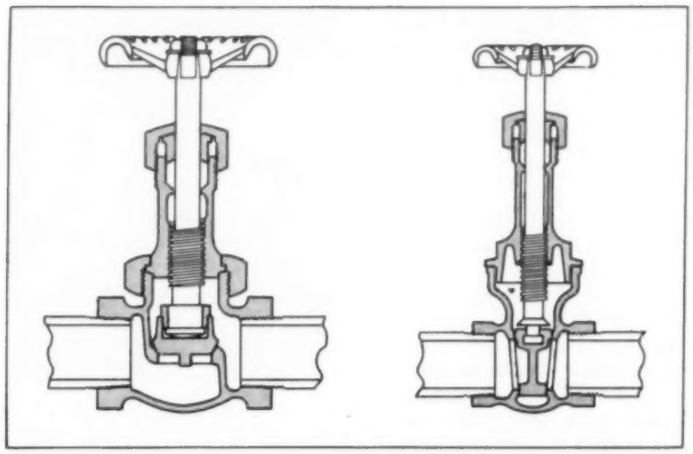

*Fig. 5 – Sectional views of globe and gate valves show that a fully open gate valve hardly disturbs flow, but globe valve always does.*

SOLUTION: Information on gate valves indicates that the equivalent length of pipe is about 6 diameters for the fully open condition, 45 for three-quarters open, 270 for half open, and 1080 for one-quarter open. Based on a preliminary solution, friction factor in the pipe is 0.022. We will assume that f does not vary with flow rate. Writing Bernoulli's Theorem between the free surface of the reservoir and the jet discharging from the pipe, and introducing expressions for the losses, we obtain the relationship:

$$\frac{p_1}{\gamma} + Z_1 + \frac{V_1^2}{2g} = \frac{p_2}{\gamma} + Z_2 + \frac{V_2^2}{2g} + h_L$$

$$0 + 5 + 0 = 0 + 0 + \frac{V^2}{2g} + \frac{V^2}{2g}\left(K_e + f\left(\frac{L}{d} + \frac{L_{valve}}{d}\right)\right)$$

$$5 = \frac{V^2}{2g}\left(1 + 0.5 + f\frac{L + L_{valve}}{D}\right)$$

or with all losses expressed in equivalent lengths, our velocity head has an $\frac{L}{D}$ of $\frac{1}{0.022} = 45.4$, and our entrance 22.7; hence, we write:

$$5 = \frac{V^2}{2g} f\,(45.4 + 22.7 + 200 + \frac{L_{valve}}{D})$$

$$= \frac{V^2}{2g} f \Sigma \frac{L}{D}$$

where $\Sigma \frac{L}{D} = 268 + \frac{L_{valve}}{D}$

Solving for the flow velocity, we find that:

$$V = \frac{\sqrt{2g\,5}}{\sqrt{f \Sigma \frac{L}{D}}} = \frac{17.9}{\sqrt{f \Sigma \frac{L}{D}}}$$

The discharge is

$$Q = AV = \frac{0.196 \times 17.9}{\sqrt{f \Sigma \frac{L}{D}}} = \frac{23.7}{\sqrt{f \Sigma \frac{L}{D}}}$$

The total equivalent length $\Sigma L/D$ varies from 274 for the open valve, to 1348 for the one-quarter open valve, and of course to infinity for the closed valve. For the open valve, discharge is 1.43 cfs, and when one-quarter open, discharge is reduced to 0.646 cfs (46% of the full flow value). The manner in which the discharge varies with valve opening is indicated in fig. 6. The non-linearity in the valve action is quite apparent. Very little throttling is seen to occur when the valve is nearly open. As long as enough pipe follows the valve to develop its loss, its location in the pipeline does not matter.

### compressibility influence for gases

Up to this point we have considered the flow of liquids and gases only to the extent that they acted as incompressible fluids. Since gases are quite compressible and most liquids slightly so, the question arises as to when we must include the effect of compressibility. In general, we find that the compressibility effect is negligible if the maximum velocity of flow is considerably less than the ve-


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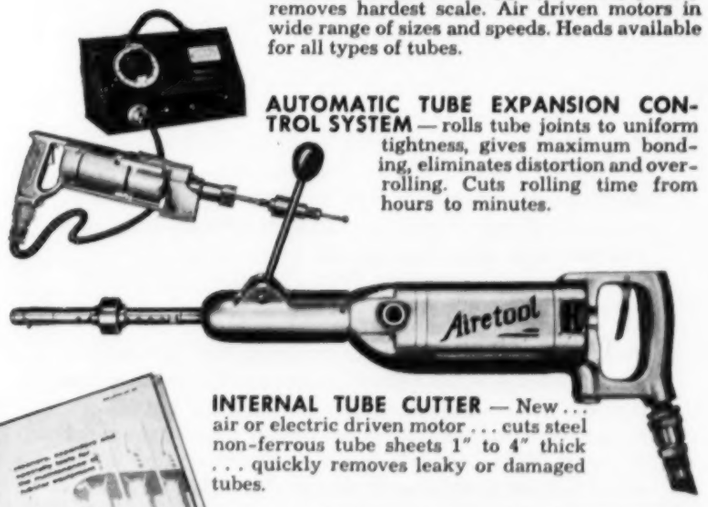


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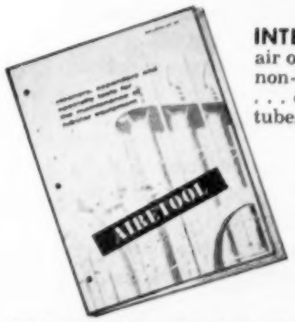


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## Fluid mechanics

. . . starts on page 22

locity of sound for the particular fluid. In fluid mechanics parlance, we say that the Mach number must be small. The Mach number, another of our dimensionless similarity parameters, is the ratio of the local velocity of flow to the velocity of sound for the fluid $\mathbf{M} = V/c$. Velocity of sound for standard air is about 1100 fps and for water is 4700 fps. Acoustic velocities of many other liquids are roughly the same as that of water. Since liquid flow velocities rarely exceed 10 or 20 fps, the value of **M** is so small that we can neglect compressibility. The acoustic velocity in a gas is smaller and varies with the square root of the absolute temperature. Gas flow velocities are often higher than liquid flow velocities, so the flow Mach number may well become large enough for there to be an effect.

To illustrate the effect of compressibility, let us consider the flow about a body in a fluid stream. At the front or nose of the body, we have a stagnation point (the velocity is zero) and pressure is given by the simple relationship (fundamental to the pitot tube):

$$p_s = p_o + \frac{\rho V^2}{2}$$

In compressible flow of a gas in which the Mach number does not exceed 0.2, this represents the conditions satisfactorily. For higher subsonic speeds, however, (but for Mach number less than unity) the following

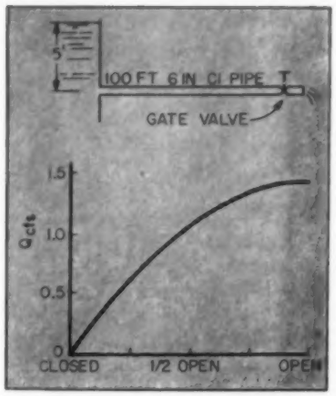



*Fig. 6 — Discharge through pipe shown as a function of valve setting. Note non-linearity.*

relationship, derived from thermo dynamics, must be used:

$$p_s = p_o + \frac{\rho V^2}{2}\left(1 + \frac{\mathbf{M}^2}{4} + \ldots\right)$$

At a Mach number of unity, the incompressible relationship is in error by nearly 25%.

Compressibility effects in conduit flow are not as simply treated. If the pipe or conduit is short and the velocities low, pressure drop and hence density change is small. In longer pipes, density change is significant. A rough rule is that if pressure drop is less than 10% of initial pressure, the flow may be treated as incompressible. This rule is only good at initial Mach numbers below 0.1 or 0.2. When compressibility must be taken into account, the solution depends upon whether the flow is isothermal, occurs in an insulated pipe, or just what the thermal conditions may be. This is beyond our present scope. ♦ ♦

### Life in a compressor

Air compressor failures resulting from foreign substances entering air intakes are not too uncommon. Hard substances are not the only trouble makers — soft particles can contaminate the oil making it sticky.

Insects are a sometimes overlooked trouble source. In some locations, air intake filters become almost clogged with insects in summer. If mosquitoes, moths, beetles, etc. enter the cylinders, they are crushed and mix with lubricant to form troublesome, gummy deposits.

*—The Locomotive of The Hartford Steam Boiler Inspection and Insurance Co.*

*Yes, Isn't it bright and airy? We blew the roof off last week . . .*

# Sizing Storage Tank Heaters for Heat-up



Hynes Electric Heating Div.
Turbine Equipment Co.

THIS NOMOGRAPH solves the equation

$$KWH = \frac{Q}{3415} = \frac{V \times .134 \times p \times 62.5 \times Cp \times \Delta T}{3415}$$

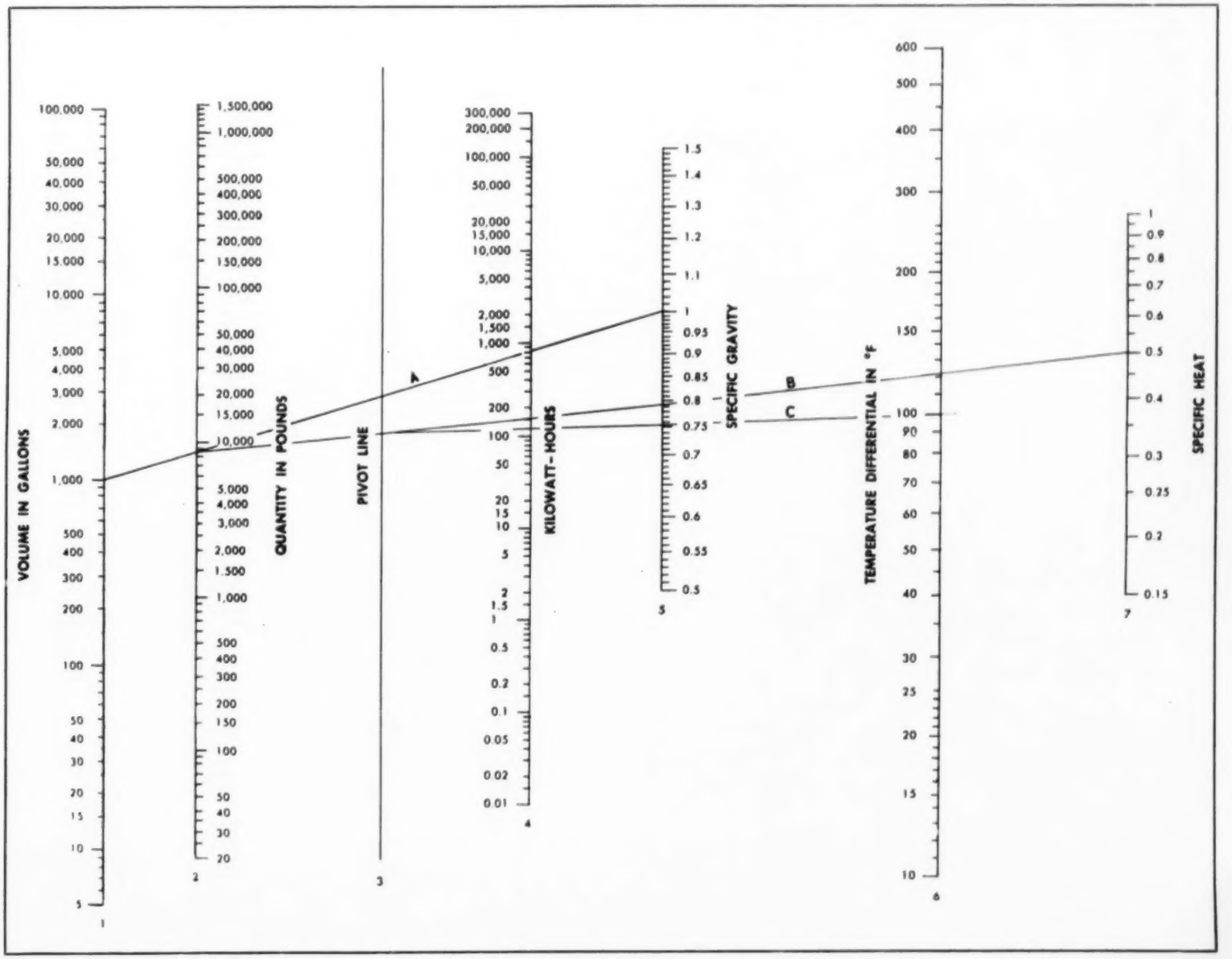
where p = specific gravity of material
V = volume of material in gallons
Cp = mean specific heat of material in Btu/lb/F
$\Delta T$ = temperature differential in F
Q = Heat required in Btu

Having determined electrical energy required in kwh, and knowing time available for heat-up, the appropriate size heater can then be obtained.

EXAMPLE: Determine rating of a heater to raise 1000 gallons of a liquid with specific gravity 1.0 and specific heat 0.5 from 50 F to 150 F in 3 hours.

Determine weight of liquid (not necessary if weight of material is known) by joining 1000 gallons on scale 1 with 1.0 on scale 5 by straight line A. Read weight of 8400 lb on scale 2. Connect this reading on scale 2 with 0.5 on scale 7 by the straight line B. Connect intersection of line B on scale 3 with 100 F on scale 6 by straight line C and read 120 kwh on scale 4. Since a total energy input of 120 kwh is required, a heater rated at 40 kw will supply 120 kwh in 3 hrs.

*(continues on page 33)*



**PI nomographs**

# Sizing Storage Tank Heaters For Maintaining Temperature

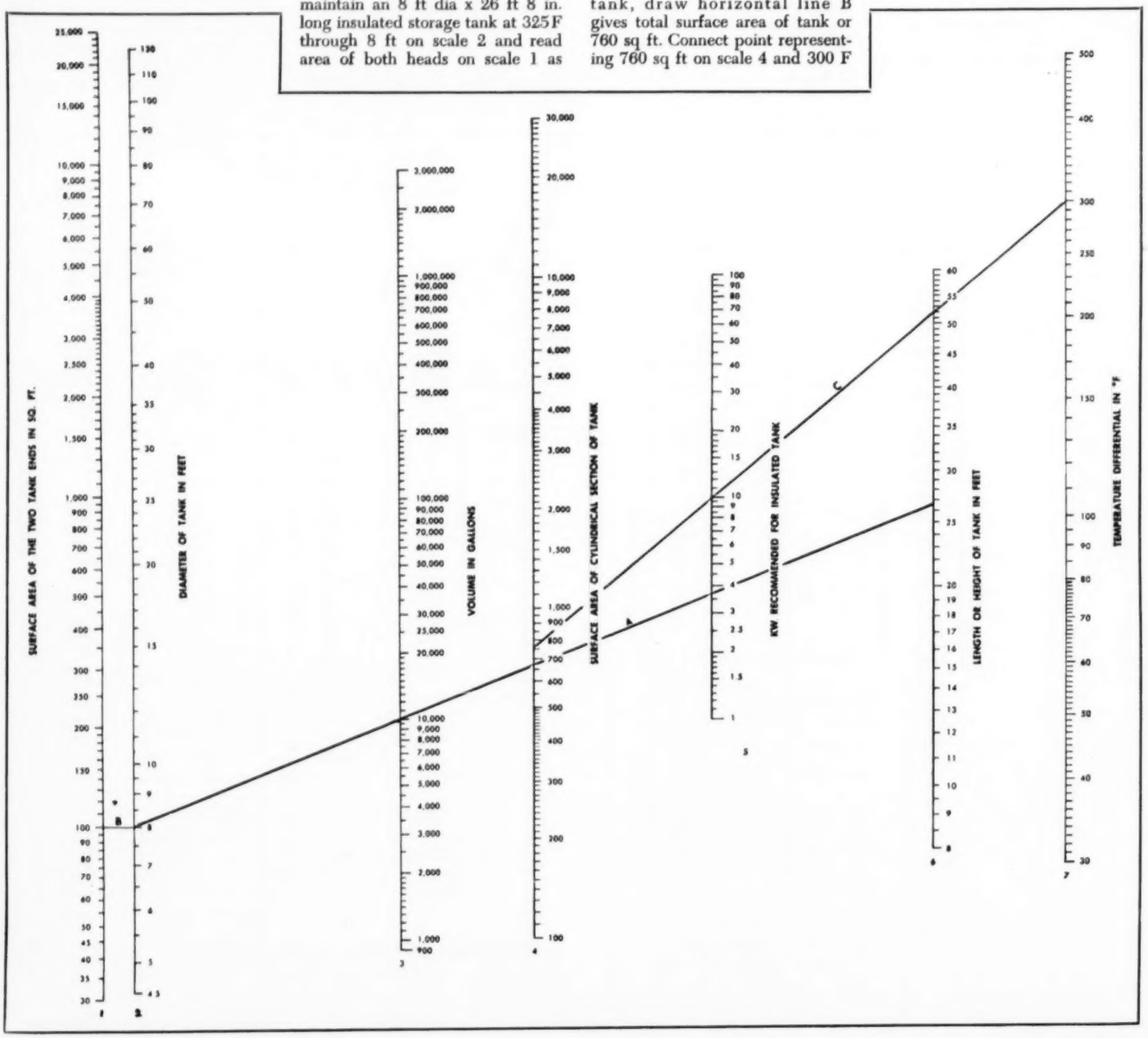


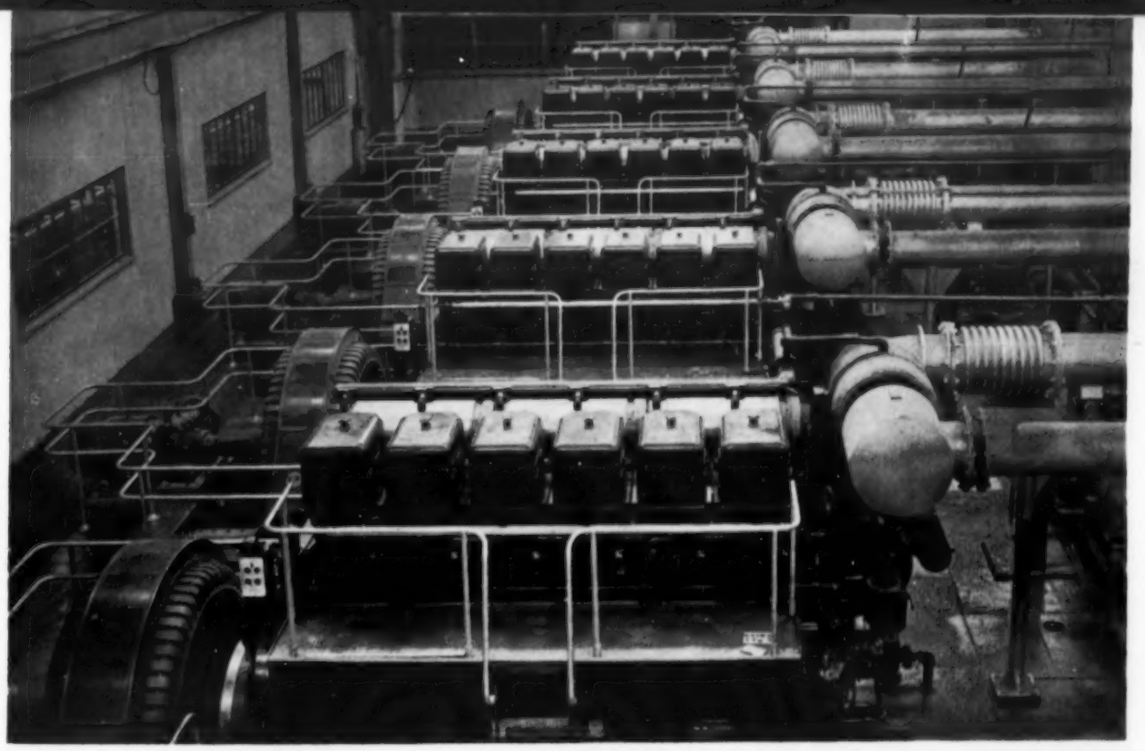
THIS NOMOGRAPH is for use with outdoor tanks with 3 in. of rockwool insulation or equivalent, and with an average wind velocity of 15 mph. Heater rating obtained is sufficient to replenish convection and radiation losses from the insulation surface. Additional kw capacity must be installed to raise the temperature of the contents. Because of the many variables involved, the result obtained is not exact, but is a close approximation.

EXAMPLE: Determine recommended kw rating of a heater to maintain an 8 ft dia x 26 ft 8 in. long insulated storage tank at 325 F through 8 ft on scale 2 and read area of both heads on scale 1 as 100 sq ft. Adding these results if ambient temperature is 25 F.

Connect 8 ft on scale 2 with 26 ft 8 in. on scale 6 by straight line A. Intersection of this line with scale 4 gives area of cylindrical portion of tank as 660 sq ft. To determine total area of both heads of tank, draw horizontal line B gives total surface area of tank or 760 sq ft. Connect point representing 760 sq ft on scale 4 and 300 F (325 F −25 F) on scale 7 by straight line C and read recommended kw at intersection of this line with scale 5 (10 kw).

Note: Scale 3 was added since intersection with line A gives tank volume in gallons. ♦ ♦


SURFACE AREA OF THE TWO TANK ENDS IN SQ. FT.
DIAMETER OF TANK IN FEET
VOLUME IN GALLONS
SURFACE AREA OF CYLINDRICAL SECTION OF TANK
KW RECOMMENDED FOR INSULATED TANK
LENGTH OR HEIGHT OF TANK IN FEET
TEMPERATURE DIFFERENTIAL IN °F
A
B
C



*These five Nordberg Supairthermal diesels provide dependable economical power at temperatures to -55 F. Exhaust gases are used in waste heat boilers to generate steam for space heating needs.*

**Diesel power plant fights intense cold to furnish . . . .**

# Power for Uranium Mining

BITTER COLD, a relatively inaccessible location, gummy glacial silt – all were conquered by Gunnar Mines, Ltd., in successfully developing a strategically valuable uranium deposit. The uranium ore is located in northwest Saskatchewan, less than 450 miles south of the Arctic Circle. Before production could begin, a diesel power plant, mining equipment, a 1250 ton/day ore treatment plant and a community to house 800 persons were required.

In this area, temperatures range from 88 F in June to –55 F in January. The average winter temperature is 10 F and the freeze-up period extends from October 25th to May 15th. The Gunnar property is located on the north shore of Lake Athabaska, 450 air miles northeast of Edmonton, Alberta and 250 miles from the nearest railroad. Thus, the only access to the property is by aircraft for personnel and light freight, and by barge (via the Athabaska River) during the summer, for heavy equipment and supplies.

Construction and operation of mine, mill, and town facilities require considerable electric power. Management of Gunnar Mines Ltd. chose a diesel-electric type power plant. Five Nordberg four-cycle diesel engines are in service and a sixth Nordberg engine is being installed. Total plant generating capacity will be 5070 kw. The six-cylinder engines (13-inch bore by 16½-inch stroke) are rated 1200 hp at 450 rpm. They are direct-connected to English Electric 845-kw, 2300-volt, 60-cps generators. During one-year operating period, the power plant generated 18,845,850 kwh and fuel consumption averaged 16.84 kwh/Imp. gal.

Extremely cold temperatures naturally present special problems for Keith Crotean, Mechanical Supt. and Oli Kristjanson, Power House Supt. The year's supply of diesel fuel, 1,600,000 Imperial gallons, is brought in by barge each summer. The tank farm located near the docks, is 800 feet from the power house. Imperial Esso fuel oil No. 46, classified as Bunker "C" or No. 5 oil, is burned. Since it has an API gravity of 10.1 and a pour point of 0F, each storage tank contains a heating coil with 42 sq ft of heating surface. This system maintains a flow of approximately 7 gpm through a 3-inch Viking gear pump, even in cold weather (–55F).

Exhaust gas from the Nordberg Diesel engines is utilized in two ways. It is initially passed through Foster-Wheeler waste heat boilers and produces 3000 lb of 50-psig saturated steam per engine at full load. The gas then passes up the exhaust pipe, which is surrounded by the scavenging air intake pipe. In this way, a constant air intake temperature is maintained.

Steam is used in heating the many plant and camp buildings. All buildings are of modern construction and are supplied with chlorinated water, electricity, and steam heat. A considerable quantity of steam is also produced in the acid plant. ♦ ♦

*Fuel-oil storage tanks are, of necessity, built above ground. Heating coils, installed in tanks, maintain a temperature to keep oil fluid.*

*For more information about Nordberg diesels, circle No. 1329 on Reader Service Card, pages 3, 50.*

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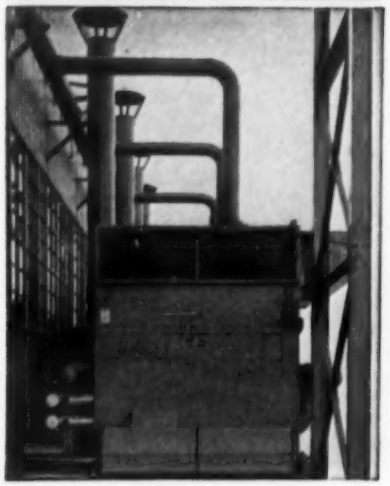

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# IP new developments

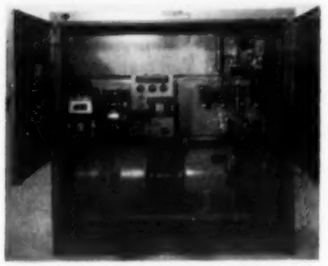
### 1300-New switchgear and circuit breakers offer quick-make manual closure, smaller size, standard parts

Redesign of I-T-E low-voltage power circuit breakers and switchgear improves performance, simplifies operation and servicing, and permits standardization formerly impossible. New K line circuit breakers have quick-make manual closure of breaker contacts to eliminate damaging arcing from careless hand closure. New breakers are about one-third smaller and 55% lighter than comparable units. Other features are a new motor-driven stored-energy system for electric breaker closure, easily interchangeable overload trips, and increased accessibility to trips and other breaker parts. Six subassemblies replace 130 separate major parts in previous models. Parts replacement formerly requiring an all-day overhaul can now be done in one hour by removing and replacing unit subassembly.

Switchgear now has closed-door draw-out. Switchgear doors can be kept shut during breaker test, during operation, and during movement to all positions. Unitized construction reduces switchgear to three basic components – breaker, switchgear enclosure, and cradle assembly on which breaker slides for drawout. Overcurrent trips are out in the open and easily adjusted. Trips for all three phases are combined on a single molding and are changed from the rear. Misalignment during replacing or changing is practically impossible. Use of trip units has been simplified – only 9 units are now required compared to 23 in former line. Each trip can be used over a much wider range of continuous load conditions. New line includes K line of 600-volt units in 225-, 600-, and 1600-ampere frame sizes; KD line having 3000-ampere rating; and KE line with 4000-ampere frame size. I-T-E Circuit Breaker Co.

### 1301-Adjustable-speed drives give accurate regulation

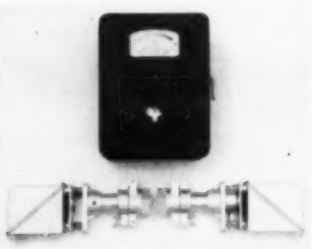
Package adjustable Speed Variators come in ratings of 3 through 150 hp and in speed ranges of 8 to 1 and higher. May be used on continuous processing lines, calendar drives, machine tools, crane hoists, metal rolling and blooming mills, paper processing machinery. Amplistat regulator gives



smooth, timed acceleration and deceleration to preset speeds in addition to voltage regulation. Static excitation system with silicon rectifier has no moving parts and needs no warm-up. Motor-generator set is two-unit, four-bearing design. Tri-Clad 55 ac motor and dc generator are connected by flexible coupling. Power unit control devices are unit-mounted and front-connected. General Electric Co.

### 1302-Measures, records smoke density

Fireye photoelectric smoke density indicators and recorders measure, indicate, and record smoke density in any pressurized duct or breeching. Light source and photoelectric scanner are installed on the stack or breeching so that light beam is aimed directly at the scanner lens.

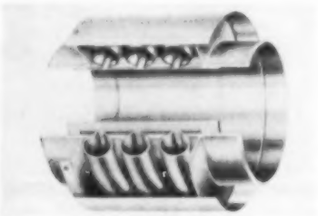


Smoke density obscuring the light beam is measured and indicated directly on the smoke density indicator in both percent smoke and Ringelmann number. An alarm relay operates an external alarm at any

preset smoke density value. COMBUSTION CONTROL DIVISION, ELECTRONICS CORP. OF AMERICA.

### 1303-Expansion joints without circumferential welds

Zallea HyPTor expansion joints protect power and process piping systems and related equipment against damage from expansion and contraction due to temperature change. Joints are formed by a hydraulic technique that eliminates circumferential welds. Toroidal corrugations have circular or oval cross-sections that, for any given pressure, produce operating stresses lower than any other corrugation shape. Thin-walled bellows reduce flexing stresses and increase expansion joint life. Corrugation roots are fully supported without welding, so that only the concave part of the corrugation is exposed to pressure. An external cover protects corrugations from accidental damage. Standard HyPTor joints are in stainless steel in 6 in. dia and larger for pressures to 200 psi with either flanged or welding connections. Joints of other materials for higher pressures or specific service conditions are available on special order. ZALLEA BROTHERS.



### 1304-Sequence valve for purging burner tips

Purge sequence valve makes possible safe steam purging or scouring of oil burner tips. Triple-interlocked valve system is actuated by a single handwheel. It dictates an inflexible and irreversible sequence in the control of atomizing steam, fuel oil, and steam for purging burner tips. Cycle prevents admission of oil to hot firebox before admission of atomizing steam, thus eliminating possible human error in the manipulation of the three separate valves usually required. ATLAS VALVE CO.

**MORE INFORMATION**

***For more detailed information on these products just circle the key numbers on a Reader Service card facing pages 3 and 50.***

### 1305-Motor starters in rain-tight housing

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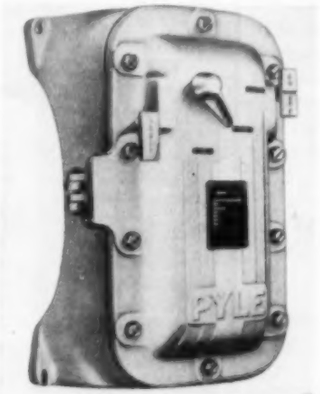


*(continues on page 38)*


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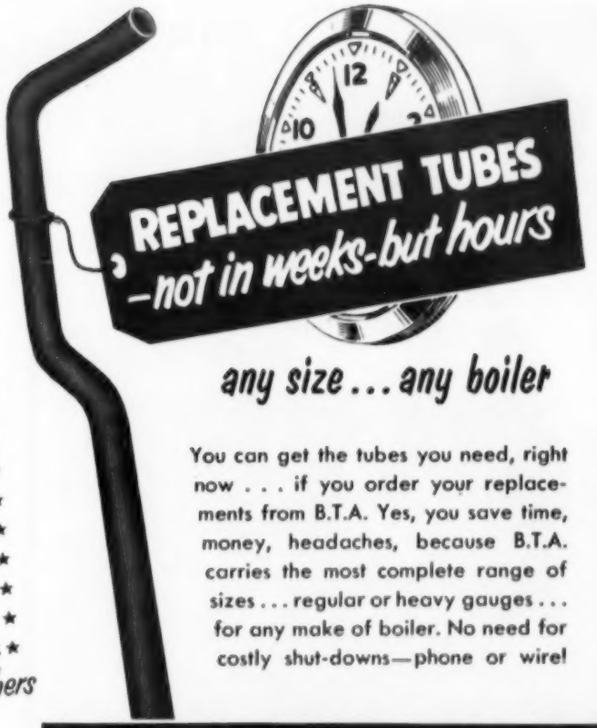
*and others*

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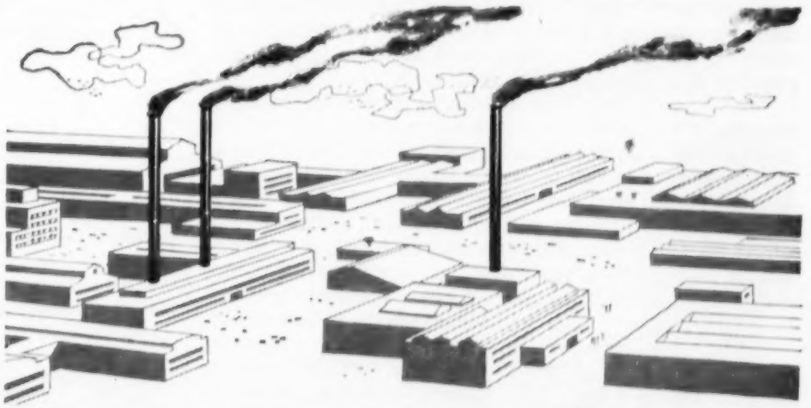

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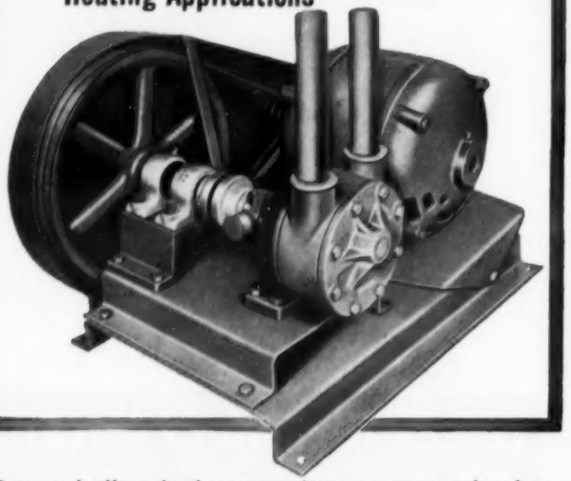
new

TUTHILL SU PUMP UNIT

- For Handling Heavy Fuel Oils
- In Packaged Boiler and Commercial Heating Applications

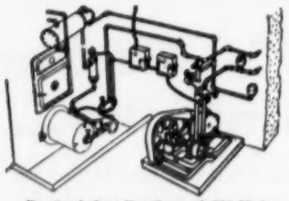


Economically priced, TUTHILL'S SU PUMP UNIT has been specifically developed for handling heavy fuel oils in commercial heating applications and with packaged boilers.

This "v" Belt Driven Unit is compact—complete units measure only 24¼" x 14⅝". Quiet operation is insured by the 2 or 4 "v" Belt Drive and the integral gear positive displacement pump design.

Construction features which provide dependable trouble-free operation, lower maintenance costs, include two ball bearing pillow blocks, one point take-up for simple adjustment of belt tension, removable belt guard and new fabricated steel base with versatile motor mounting.

SU PUMP UNITS can be furnished with a wide variety of pumps and motors for pressures up to 300 psi, capacities to 2030 gallons per hour. Sub-assemblies of pump, stub shaft, pillow block and sub-base are also furnished separately as a unit for incorporation into systems by boiler and furnace manufacturers. Write today for complete information.



Typical Application of SU Unit

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Gentlemen:
Please forward Catalog describing Tuthill SU Pump Units.
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STREET_____
CITY_____ STATE_____

TUTHILL PUMP COMPANY
951 East 95th Street, Chicago 19, Ill.
Canadian Affiliate: Ingersoll Machine & Tool Company, Ltd., Ingersoll, Ontario, Canada

PUMPS FOR YOUR PURPOSE

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## P/I new developments

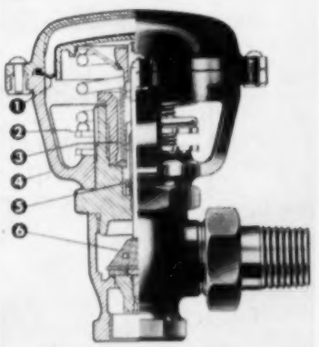
. . . starts on page 36

### 1306-Gage measures pipewall thickness

AccuRay portable pipewall thickness gage permits quick, easy, direct measurement of pipewall thickness on pipes of 2 to 8 in. dia. Transistorized gage operates on radiation absorption principle. Measurement unit gives a reading independent of pipe diameter, maintains a permanent calibration. Reproducibility and resolution of better than ±0.010 inches are achieved throughout the range of 0 to 1-inch thick pipewalls. Nonferrous or plastic piping in this range also can be measured. INDUSTRIAL NUCLEONICS CORP.

### 1307-Packless valve is corrosion resistant

Corrosion-proof, adjustable packless valves give improved control of unit conditioners, unit ventilators, and convectors. Powertop pneumatic valve features include externally adjusted and easily accessible spring that adjusts to close at 5 to 12 psi top pressure; lower housing of high-impact phenolic to eliminate electrolytic corrosion be-





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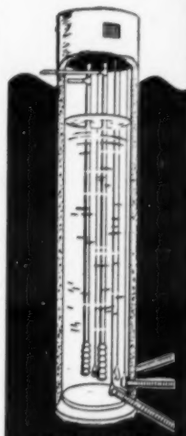
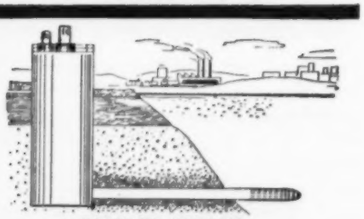


CONVENTIONAL COLLECTOR

INFILTRATION GALLERY

RANNEY VERTUBE



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**THE RANNEY INFILTRATION GALLERY** provides low cost water supply to industry and community. The gallery provides large quantities of clear non-turbid water in a revolutionary yet economical way, and it requires no maintenance.

**RANNEY VERTUBE.** A natural gravel vertical water well at low cost, developed exclusively for low volume users. Engineered with the same precision and efficiency that has made Ranney a *must* for communities.

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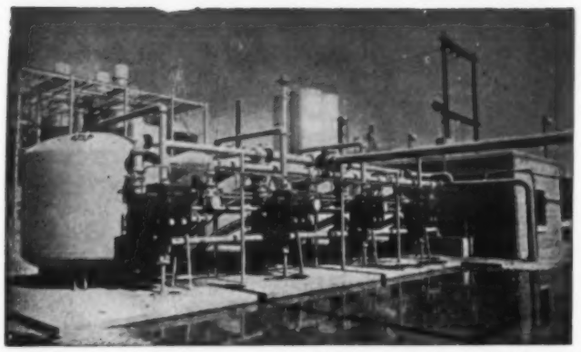

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***(for over half a century)***

Complete plants for water softening, demineralization, silica removal, de-oiling of condensate, clarification, de-alkalizing and all other requirements.

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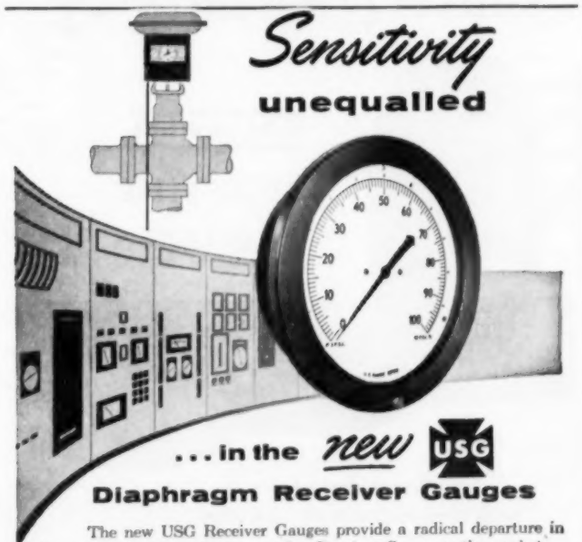


The new USG Receiver Gauges provide a radical departure in design and performance from any other Receiver Gauge on the market.

The key to the design is a stack of nested diaphragms . . . made of Ni-Span "C", a special high nickel alloy with a minimum thermal shift, even under wide variations in ambient temperature. These capsules are arranged in stacks occupying minimum space yet providing a sturdy element with extended travel for precise pointer response.

Standard USG Receiver Gauges provide a sensitivity of 1/10 of 1%, accuracy of ±¼ of 1% . . . both based on full scale readings, and are available in a choice of 4½", 6" or 8½" dials.

Write today for details on the USG Receiver Gauge.

**USG UNITED STATES GAUGE**

Division of American Machine and Metals, Inc.
Sellersville, Pa.

*Home of the* SUPERGAUGE

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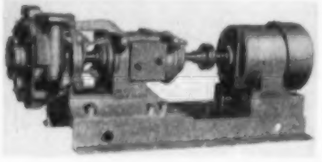
tween housing and internal metal parts; and silicone diaphragm that gives 60% more closing power. Packless bellows eliminate leakage and maintenance — life expectancy is 10 to 15 years. Quad ring at base of bellows prevents steam or water leakage and vacuum loss if bellows should become damaged, permitting normal valve operation until damaged bellows is replaced. Bellows are of two types: low-pressure bellows for system static pressures to 100 psi; or high-pressure bellows for pressures to 180 psi. POWERS REGULATOR CO.

### 1308-Pump discharges in four positions

Series H single-stage end-suction centrifugal pumps are available in sizes from 1 to 10 inches, heads to 250 feet, capacities to 4000 gpm. New line includes three standard types: HR for abrasive mixtures where head



is limited; HC with split bearing stand for corrosive applications; HF for abrasive or corrosive applications where high pressures are developed. Waterend or casing can be rotated to any one of four positions for discharge of pumped material. Slippage seal can be adjusted quickly — wrench is only tool needed. NAGLE PUMPS, INC.

### 1309-Steam traps have rotating valve

Bucket, valve, and impeller of steam traps operate as an integral unit. Impeller changes seating position of valve at every discharge to prevent uneven wear of valve and orifice, wire drawing, and steam leakage. Impeller action also keeps sediment agitated so that it passes out with each condensate discharge. Removable cap permits valve and seat inspection without disturbing bolts or gaskets. H. O. TRERICE CO.

*(continues on page 40)*

New Parker Intru-lok fittings for instrumentation tubing
• To connect a Parker Intru-lok flareless fitting, you don't take it apart.
• Simply push tube in, then tighten Intru-lok nut. Foolproof; easy to use.
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**USE Armstrong Ball Float Air Relief Traps for venting air from hot water heating and supply systems or for venting any gas from any liquid.**

**They're less trouble, fuss and worry. They get rid of air fast —always work. Wear and corrosion resistant chrome and stainless steel inner parts mean long life and negligible maintenance.**

**A size and style for every requirement. Satisfaction guaranteed or your money back.**

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***Send today for free Air Relief Trap Bulletin.***

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**8209 Maple Street, Three Rivers, Michigan**

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## PI new developments
. . . starts on page 36

### 1310-Valve protects turbine against over-speed

Reheat header spring-loaded safety valve now gives extra protection against over-speed of low-pressure turbine if intercept valve fails to close on loss of turbine load. An air lift cylinder raises conventional spring-loaded valve to its full discharge capacity at any pressure to zero. Opens valve to full capacity in less than 0.1 second. Air lift mechanism is controlled by an over-speed switch that acts instantly if an over-speed due to loss of load occurs. By opening reheat safety valves immediately on an increase in turbine speed, header pressure is relieved and cause of over-speed is removed. CROSBY VALVE & GAGE CO.

### 1311-Transmits pressure and liquid level

Pneumatic pressure and liquid level transmitter measures to 250 psi or 0 to 100 inches of water. Operating on force-balance principle, Model F transmits a linear 3 to 15 psi signal to a recorder, indicating gage, or manometer. Ideal for services involving viscous fluids or materials that solidify in static lines of pressure elements in conventional pressure transmitters. Mounts horizontally or vertically on open or closed tanks. Only corrosion-resistant Inconel X diaphragm comes in contact with measured material. CONOFLOW CORP.

### 1312-On-the-job bending of electric conduit

PJ 100, latest model in Power Jack line of portable Benfield Benders, bends ¾ inch Sheraduct, other rigid steel conduit and 1-inch duct Junior metallic tubing. Two-position foot treadle booster step gives constant, heavy foot leverage. Other features include an integral back pusher to true up and straighten bends, a safety collar for handle thread protection, and outrigger stabilizers on the bender. hook for balance. NATIONAL ELECTRIC PRODUCTS CORP.

### 1313-Temperature regulator for slow-heating units

Temperature regulator consists of Spence Type E main valve controlled by T14 pilot for accurate regulation of such slow heating units as oil or water storage heaters, plating tanks, kilns, and ovens. T14 pilot automatically opens and closes main valve to steam supply as required to maintain constant temperature. Regulator applies line pressure to heating equipment. Pilot is interchangeable on any Spence main valve. SPENCE ENGINEERING CO., INC.

For more details

For more detailed information on these products, just circle the key numbers on a Reader Service Card, facing pages 3 or 50.

One dependable quality

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*From raw material to final inspection every part is MADE and ASSEMBLED under our own quality control.*

STRATEGICALLY LOCATED WAREHOUSE STOCKS

Manarch ELECTRIC CORPORATION
Jamestown, New York

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### 1314-Regulating valves have clean-out plug

Series E-93 pressure-reducing valves give accurate regulation for service on cold water or hot water to 200 F. Pipe sizes are ½ to 2 inches. Construction features include all bronze housing, brass internal parts, heat-resistant seat disc and diaphragm. Monel strainer screen protects working parts, has separate clean-out plug for convenient flushing. Disc seating arrangement reduces chatter. A. W. CASH VALVE MFG. CORP.

YOU CAN GET 43 STOCK SIZES 1/8" to 3"

SOLID STEEL COLLARS

Size-marked for quick identification in 43 stock sizes

And these precision-machined solid steel collars stay put because they are held in place on the shaft by the famous UNBRAKO Self-Locking Socket Set Screw. Authorized industrial distributors carry complete stocks in sizes from ⅛" to 3" inclusive. Write for Bulletin 868. STANDARD PRESSED STEEL CO., Jenkintown 39, Pa.

STANDARD PRESSED STEEL CO.
HALLOWELL POWER TRANSMISSION DIVISION
SPS
JENKINTOWN PENNSYLVANIA

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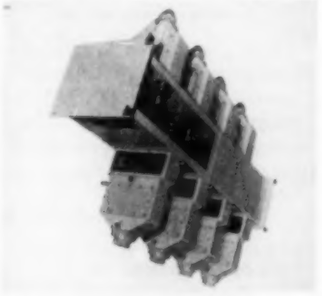
### 1315-Valve stem packing has Teflon suspensoid

Type 5022 valve stem packing for medium service is made from copper wire and asbestos yarns braided together and impregnated with Teflon suspensoid, then die-formed into rings. Special characteristics include mechanical strength and extreme toughness to withstand seepage and physical abuse; elimination of graphite or liquid lubricant

that might dry out, burn out, or exude; heat resistance for temperatures to 500 F; high degree of chemical inertness (there is no known solvent for Teflon); and ability to withstand contamination. THE GARLOCK PACKING CO.

### 1316-Disconnect, bus duct combine in one unit

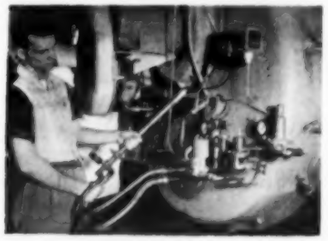
Iso-Duct combines disconnect Isolator and bus duct, arranges them to permit future extension in either direction. Any number of Isolator and pothead combinations may be easily interchanged whenever power demands vary or expansions alter power needs. Isolator working parts are fully enclosed. Straight-line telescoping action



performs disconnect operations in one-third the space needed by comparable blade-type switch. ELECTRICAL ENGINEERS EQUIPMENT CO.

### 1317-Cleaning burner nozzle is simplified

C-B boilers 60 hp and larger now have flexible lines with single tip retractable nozzle for easy inspection without removing bolts. New nozzle gives more stable combustion and more



positive mixing action of oil and air. Other C-B boiler features include four-pass construction, forced draft, 5 sq ft of heating surface per boiler horsepower, and vibrationless impeller on blower motor shaft for extra-quiet operation. CLEAVER-BROOKS CO.

### 1318-Refrigeration oil always protects

Suniso 3G all-temperature oil is designed to work well with all modern refrigerants, including Freon-22, Isotron-22, and Genetron 141. Suniso 3G gives lower floc point, greater stability, and increased copperplating resistance. SUN OIL CO.

### 1319-"Do-it-yourself" steel buildings

Stran-Master all-steel pole-type building line makes possible industrial utility buildings for as little as 70¢/sq ft on a "do-it-yourself" basis. Stran-Master units come in standard widths of 12 to 120 feet and lengths to any multiple of 16 feet. Windows and doors can be placed anywhere, and any or all walls may be open. A 36- by 72-foot Stran-Master unit can be put up by an unskilled maintenance crew in 180 to 200 man-hours. All framing connections are bolted using factory-drilled holes. Self-levelling feature, consisting of adjustable columns and girts, gives easy plumb and squaring. After steel columns are placed in the ground their height is adjusted to correct any construction irregularities, then secured with locking nuts. Concrete is poured into the hole around the column base and into the column cavity. STRAN-STEEL CORP.

### 1320-How to determine phase rotation

Pocket-size Phasometer indicates phase rotation on 3-phase 60 cps systems for 115 to 575 volts. Also indicates live circuits, blown fuses, and grounded lines on a 4-wire or 3-phase system.

Phasometer's polystyrene housing is 1 inch dia by 3¼ inches long, with three colored leads to clip to power lines. Total weight is only 2.5 ounces. W. A. WALTERS CO.

### 1321-Photo-copy machine copies from books

Contoura-Portable photo-copy machine operates on normal office lighting on same setting for all material. Plastic air cushion permits it to be put face down on bound books so that it can follow page contours right to the page margins. Produces a permanent copy of anything

printed, written, or drawn. Copies all colored inks, crayon, pencil, spirit duplicator copy in 30 seconds for 11¢/page. F. G. LUDWIG CO., INC. ♦♦

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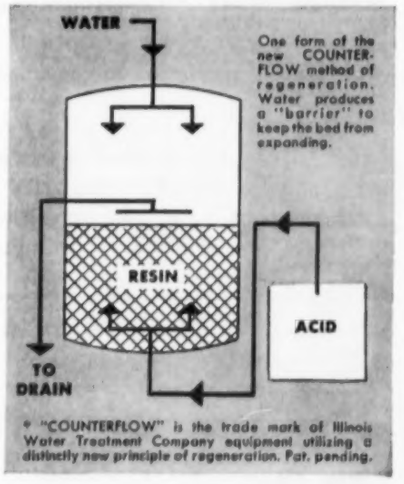
# COUNTERFLOW*
## REGENERATION OF ION-EXCHANGERS


WATER
One form of the new COUNTER-FLOW method of regeneration. Water produces a "barrier" to keep the bed from expanding.
RESIN
ACID
TO DRAIN
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- Ion leakage is reduced to about 1/3 of the amount common to conventional regeneration techniques.
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- Removal of organics from the resin is improved.
- The possibility of calcium sulfate precipitation is decreased, permitting single-stage regeneration.
- Rinse water requirements are reduced.
- In systems using a two-bed deionizer ahead of a mixed-bed unit, ions can be removed more completely in the more efficiently regenerated two-bed unit, thereby reducing the load on the mixed-bed unit.

*Present users of "COUNTERFLOW" are enjoying IMPROVED purity of effluent at LOWER cost of regenerant materials. One power plant, for example, is saving $16,000 a year on acid alone since converting existing de-ionizers to COUNTERFLOW design.*

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Total connected electric load _____ kva
Total transformer capacity _____ kva
Total number electric motors _____ Total hp _____
Total number pumps _____ Total hp _____
Total number compressors _____ Total hp _____
Products manufactured _____
Signed _____
Date _____

## PI handy guide to engineering literature

### AIR CLEANING EQUIPMENT

**1203-Manual of dust collection**

"The Collection and Recovery of Industrial Dusts," Manual 101, discusses types of dust and techniques used in analysis of industrial dusts. 32 pages. Buell Engineering Co., Inc.

### AIR CONDITIONING, HEATING, VENTILATING

**1200-Certified ratings for fans, ventilators**

New Air Moving and Conditioning Assn. program will identify air moving equipment according to manufacturers' stated ratings. Program hopes to protect specifiers and users of centrifugal, axial, and propeller fans and power roof ventilators against incorrectly or improperly rated equipment. Bulletin 153-57 describes AMCA program. 4 pages. Air Moving and Conditioning Assn.

**1201-Physical data on distributing coils**

Bulletin B-1418 describes Type D-1 double-tube steam distributing coils for heating system applications. Useful data includes tables on final air temperature and temperature rise correction factors; air friction tables; piping instructions; typical piping diagrams. 8 pages. American Blower Div., American Standard.

**1202-Get cooler, drier air**

How aftercoolers remove moisture from compressed air and gas is explained in Bulletin 130. Schematic flow diagrams show how aftercoolers can cool and dry compressed air systems in any plant. 8 pages. Niagara Blower Co.

**1206-How to solve your air-moving problems**

Industrial fans designed for high-volume air movement are described in two bulletins: 750-A for belt-driven fan data, and 775 for direct-driven fans. Bulletins give complete data on construction features, installation details. Aerovent Fan Co., Inc.

### BOILERS AND ACCESSORIES

**1204-Data on steam jet exhausters, compressors**

Bulletin 4E describes air and gas pumps that operate on jet principle at moderately high vacuum for such services as pump priming, exhausting, evacuating, cleaning, transporting, compressing, agitating, and general vacuum service. Live steam or air is motive force. Bulletin gives application, construction, and operation data. 8 pages. Schutte and Koerting Co.

**1205-Handy boiler selection survey**

By answering Boiler Selection Survey questions, engineer or purchasing agent responsible for new boiler installation can choose most appropriate and efficient boiler type and size. Survey covers boiler room, electric supply, fuel, special components or openings, feedwater, noise control, steam requirements. 6 pages. Orr & Sembower, Inc.

**1207-How to improve heat transfer from steam**

C-B system for fast, uniform heat transfer from steam is described in Bulletin 6025. System returns condensate to boiler or makeup system at process temperature for lower steam costs. Cochrane Corp.

**1208-Specifications on dual-stage burners**

Bulletin 25 describes advantages of dual-stage burners that

combine advantages of both steam and mechanical types. Ideal for firing petroleum processing heaters, rotary kilns, scotch marine, and water-tube boilers. National Airoil Burner Co., Inc.

## BUILDING MATERIALS

**1210-How to cut smokestack corrosion**

Permaglas smokestacks are glass-protected inside and out to protect against acid condensate, thus reducing corrosion. Bulletin SS-202 gives details. 8 pages. A. O. Smith Corp.

## COMMUNICATIONS SYSTEMS

**1211-Gives specs on Laytex cables**

Latest edition of "Specifications for Municipal Communications Control, Signal and Power Cables" gives latest specifications on police communications, traffic, and fire alarm systems. Includes approved specifications for 300-volt Laytex braided cables, 600-volt Laytex resin cables of the IMSA type, and 300-volt Laytex resin cables. 210 pages. Kaiser Aluminum & Chemical Sales, Inc.

## COMPRESSED AIR SUPPLY

**1209-Dehumidifiers for instrument air**

Adsorptive-type automatically regenerated dryers with capacities to 125 cfm at 90 F and 100 psig are described in Bulletin 857. Air dryers are designed to automatically lower air dewpoint to prevent moisture condensation in delicate instruments. Bulletin includes complete mechanical specifications and sizing nomograph. 4 pages. Anders-Lykens Corp. Div., Milton Roy Co.

**1213-Package unit substation data**

Bulletin SD-61 reviews advantages of substations in modern electric distribution systems. Describes substation equipment and high- and low-voltage components. 8 pages. Square D Co.

**1214-Design features of high-voltage starters**

Type H front access high-voltage starters for 2300- to 5000-volt motors are described in Bulletin 14B8507. Features include roll-out air-break contactor for easy inspection and maintenance, optional oil-immersed contact for services where dust, dirt, moisture, or corrosion is a problem. 8 pages. Allis-Chalmers Manufacturing Co.

**1215-Test switchgear with compartment door shut**

Low-voltage, metal-enclosed, drawout switchgear permits tests with doors closed—with no increase in overall switchgear depth. Bulletin 6004B gives complete data on models in line, components available. 12 pages. I-T-E Circuit Breaker Co.

**1216-Power transformers for 5000 to 50,000 kva**

Bulletin GEA-6604 describes "Preferred Design" power transformer line. Gives performance data, prices, dimensions and weights for typical ratings from 5000 to 50,000 kva, 69 to 138 kv, with or without load tap changing. Uniform mechanical features and accessories were selected as a result of nationwide survey among power transformer users. 40 pages. General Electric Co.

## HEAT EXCHANGERS

**1217-Compression still, flash evaporator data**

New bulletin describes three types of water evaporators: vapor compression unit, flash evaporator, and centrifugal compression still. Includes data on capacities, weights, space needs for various models. 8 pages. Evaporator Div., Badger Manufacturing Co.

## INSTRUMENTS AND CONTROLS

**1219-Pneumatic controller has easy band adjustment**

Type VC pneumatic controller described in Bulletin 57-2 features an easy proportional band adjustment with less than 0.05% dead band. Either remote pneumatic or local spring set point adjustment available. Bulletin gives complete details on installation, operation. 4 pages. Republic Flow Meter Co.

**1220-Liquid-level gage, valve data guide**

Bulletin 305 describes standard and special-function gages

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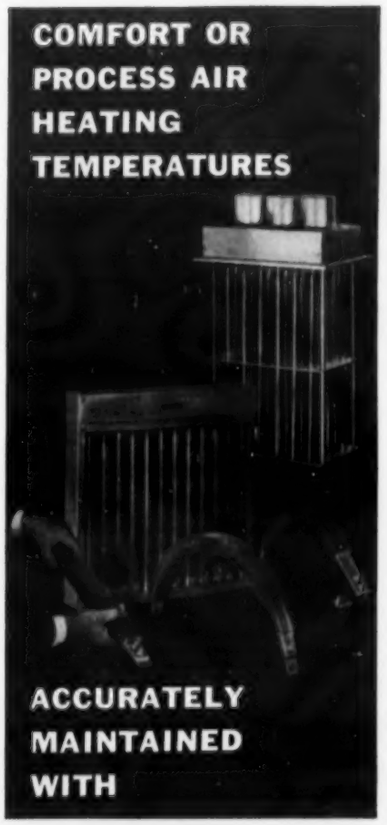


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**handy guide**
. . . starts on page 42

and valves. Gives dimensional drawings, construction features. pressure-temperature graphs and ratings, materials, size tables, specifications, optional features 8 pages. JERGUSON GAGE & VALVE CO.

**Here's Real Proof of the Superiority of Hartzite Plastic Cooling Tower Fans**

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**1221-Guide to insulation, resistance testers**

Megohmer insulation and resistance testers described in Bulletin 1248 are of three types: dc generator hand-crank; noncranking battery vibrator; or plug-in. Bulletin gives complete details on all models in each type. 4 pages. HERMAN H. STICHT CO., INC.

**1226-New charts simplify regulator valve sizing**

Charts in Bulletin J-SC aid in sizing OPW-Jordan sliding-gate regulator valves. Technical data that applies to all valve makes, covers pressure, temperature, viscosity, specific gravity. 4 pages. JORDAN CORP.

**1222-Electric heating element design do's and don'ts**

Manual M-57C gives prices and specifications for standard Chromel-C wire, a 60-16 nickel-chromium-iron resistance alloy, for electric heating applications to 1700 F and cold resistor applications to 800 F. Covers heating element design factors, tables on current-temperature relationship, design tips. 16 pages. HOSKINS MFG. CO.

**1223-Calibration chart for thermocouples**

Handy chart gives color codes and calibration symbols for thermocouples and thermocouple extension wires plus pyrometer wire resistance figures. One side of chart gives wire calibrations with ISA symbols and color codes. Reverse side gives resistance tables for standard pyrometer wires in ohms per 100 feet at 68 F. Chart is 8½ by 11 inches on heavy, plastic-laminated card stock. THERMO ELECTRIC CO., INC.

## LUBRICATION

**1224-Lists lubricants for 560 services**

Charts in bulletin lists 560 fluids that lubricated plug valves handle. Recommends lubricants, with their service range, description, and temperature range. Includes data on lubricated plug valve installation, adjustment, operation, maintenance, and on high-pressure lubricant gun. 12 pages. WALWORTH CO.

**1225-Help on tough lubrication jobs**

New bulletin describes tough industrial lubrication jobs, tells how E. P. products solve specific problems. Describes products for various applications. 16 pages. BROOKS OIL CO.

## MAINTENANCE ITEMS

**1229-Teflon seals resist solvents, corrosives**

Chempac Teflon Clipper Seals are designed to give positive sealing against active solvents and corrosives. Seal body is of Teflon encased in stainless steel or other corrosion-resistant alloy. Bulletin PK-124 describes Chempac Teflon and asbestos-Teflon packings and gaskets. 16 pages. JOHNS-MANSVILLE CORP.

**MORE INFORMATION**

*To obtain copies of these bulletins and data sheets, just circle the key numbers on a Reader Service Card, pages 3 and 50.*

**1227-Handy chart gives data on stainless steel**

Government specifications on stainless steel can be quickly determined with new chart. Chart shows chemical analysis requirements most frequently used for government defense projects. Also lists specified forms (bars, wire, etc.) and nearest corresponding SAE, AISI, and AMS type numbers. Chart is standard file drawer size. PETER A. FRASSE & CO., INC.

**1228-How to get better welds**

Handy pocket-size Bulletin EW-201 gives information on metals and electrodes, proper

welding procedures, fillet welds, welding symbols, common welding troubles. Explains AWS classification numbers; gives comparative index of welding electrodes. 60 pages. HOBART BROTHERS CO.

**1230-Boiler tubes need cleaning, replacement?**

Bulletin 60 describes precision-made boiler tube maintenance tools. Gives data on cleaners, cutters, and expanders, including size, weight, and operating speed. AIRETOOL MANUFACTURING CO.

## MANAGEMENT

**1231-Aid for overworked engineering staffs**

Allstates' engineering and design services can be used to smooth out peak engineering department loads or to supply specialized engineering services anywhere in the U. S. Bulletin describes services offered by Allstates to chemical, construction, atomic, manufacturing industries. 6 pages. ALLSTATES DESIGN & DEVELOPMENT CO., INC.

## MATERIALS HANDLING (BULK)

**1233-Convey bulk materials pneumatically**

Bulletin 530 tells how pneumatic conveying solves problems of handling powdered or granular bulk materials. Bulletin lists materials that can be handled by this method, describes specially engineered systems, gives diagrams of typical installations. 32 pages. DRACCO CORP.

**1232-Dry chemical feeder is self cleaning**

Bulletin TP-9-M gives complete details of dry chemical feeder with a hopper capacity of 3¼ cu ft. Dustproof feeder is of heavy gauge steel with corrosion-resistant finish. Self-cleaning feed screw discharges chemical alternately from each end of feed tube. While one end is discharging chemical, the other is cleaned by being threaded through the material. 4 pages. WALLACE & TIERNAN INC.

**1234-How to store bulk materials**

Storage bins for bulk materials such as ashes, coal, coke, sand or lime are discussed in this bulletin. Contains tables of densities of flowable materials, capacities, description of wall construction, test data, and other relevant engineering data with many photographs. 30 pages. THE NEFF & FRY CO.

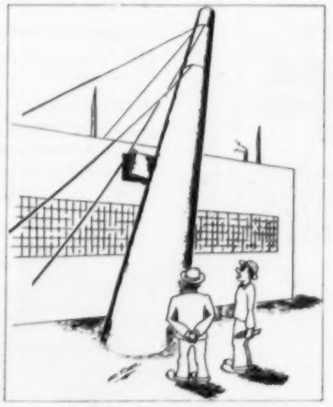
## MECHANICAL POWER TRANSMISSION

**1237-Easy way to choose speed reducers**

Handy arrangement of specifications in Bulletin CD-230 simplifies selection of speed reducer of the exact capacity, type, and ratio for any given job. Covers standard double-reduction speed reducers in ratios from 75:1 to 4900:1 in worm over, worm under, or gear shaft vertical models. Output torque ratings to 618,000 inch-pounds. 20 pages. CONE-DRIVE GEARS DIV., MICHIGAN TOOL CO.

**1235-Data on belts for heavy-duty power drives**

Bulletin 6638 describes Poly-V drive that offers 50% more power than ordinary belts of



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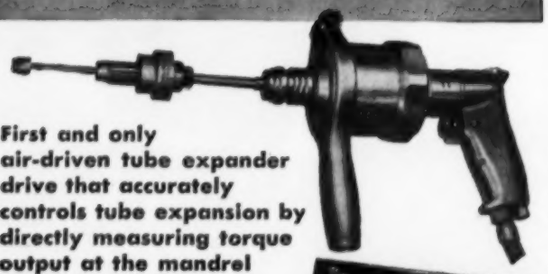

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P1 handy guide
. . . starts on page 42

equal width. Two cross sections of Poly-V belt meet every heavy-duty power requirement. Bulletin gives complete test data, specifications. MANHATTAN RUBBER DIV., RAYBESTOS-MANHATTAN, INC.

**1238-Geared flexible couplings transmit more power**

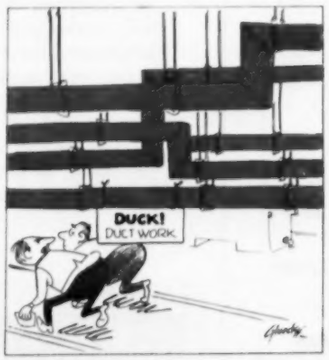
Bulletin 2775 describes geared flexible couplings with maximum bores to 7 inches and ratings of 2½ to 572 hp/100 rpm. Couplings have extra large bore capacity in proportion to outside diameter to transmit more power. Quad-ring hub seals retain lubricant; keep out dust, water. 12 pages. LINK-BELT CO.

**1239-Power transmission belt reduces bearing loads**

Unique friction properties of power transmission belting running surface eliminate slip and considerably reduce bearing loads, even at higher pulley ratios. Bulletin describes belting made of polymer and chrome tanned leather. Gives data on selecting proper belt type, tensioning and maintenance, bearing load reduction. 12 pages. EXTREMULTUS, INC.

**1240-Solid steel collars that stay put**

Bulletin 868 describes precision-machined solid steel col-

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lars. Unbrako self-locking socket set screw holds collar in place on shaft so it can't slip. Stock sizes from ⅛ to 8 inches. HALLOWELL POWER TRANSMISSION DIVISION, STANDARD PRESSED STEEL CO.

### 1241-Catalogs V-belts for all variable-speed units

Reference book gives complete cross-reference information on every variable-speed V-belt for every type or make of unit. Interchange data includes drive information and manufacturer's list of parts. 24 pages. DAYTON RUBBER CO.

## NUCLEAR

### 1242-Application guide for saturable power reactors

Bulletin F-8383 describes saturable power reactors, their turn down characteristics, and automatic control systems. With proper controls, saturable reactor can control ac power to furnaces, heaters, other equipment supplying resistive loads. BARBER-COLMAN CO.

## PIPING, TUBING, AND HOSE

### 1243-Seamless metal hose for power systems

Catalog describes custom-constructed hose assemblies for industrial power systems. Gives complete data on all sizes in bronze, stainless or carbon steel, monel, inconel, and low carbon nickel. COBRA METAL HOSE.

### 1244-Easy way to join steel, aluminum pipe

Vic-Easy method joins thin-wall steel and aluminum pipe and tubing by a quickly installed coupling. Gives positive, leak-tight connection. Bulletin includes complete details on couplings, list of applications for which method is suitable. VICTAULIC CO. OF AMERICA.

## PUMPING EQUIPMENT

### 1245-Motor pump performance guide

Catalog 107 covers Tuthill Type-SU pump units for handling heavy fuel oils and other noncorrosive, highly viscous liquids. Units deliver pressures to 300 psig, capacities to 2030 gph. Handy performance guides help you select best unit to fill any need. Dimensions, operating characteristics, pump and motor performance data are included. 8 pages. TUTHILL PUMP CO.

### 1246-Engineering report on hydraulic pumps

Special engineering report gives details of BJ pumps for a variety of service conditions. Includes detailed flow diagrams, color photographs of actual installations and complete engineering and operating data. BYRON JACKSON PUMPS, INC.

## REFRACTORIES AND INSULATION

### 1247-Engineering specs on 19 industrial sheet packings

Bulletin P-328 gives detailed specifications and engineering, application, and test data on 19 varieties of industrial sheet packings. Packings are of asbestos, rubber, neoprene, silicone, fiber, and Teflon. All are available in die-cut gasket form in any shape and in all standard sizes. 8 pages. CRANE PACKING CO.

## TRAPS, STRAINERS, SEPARATORS

### 1248-Ball-float traps that fit all needs

Ball float traps for draining water from air, gas, or steam lines or for draining light liquids from gas under pressure are described in Bulletin 289. An orifice capacity chart and tables of maximum operating pressures help in selection. 8 pages. ARMSTRONG MACHINE WORKS.

## VALVES AND REGULATORS

### 1249-By-pass valve permits in-line servicing

Bulletins V-210 and V-211 describe three-way by-pass valves that permit in-line servicing, simpler straightaway piping with no elbows. For pressures to 250 psi at 400 F and 400 psi at 70 F. JOHNSON SERVICE CO.

## WATER SUPPLY AND TREATMENT

### 1250-All phases of water purification

"Boiler Feedwater Treatment," Bulletin BFT-1, covers Inversand zeolite softeners, color process chemical softeners, and demineralizing units, including silica removal by ion exchange. 20 pages. HUNGERFORD & TERRY, INC. ◆◆


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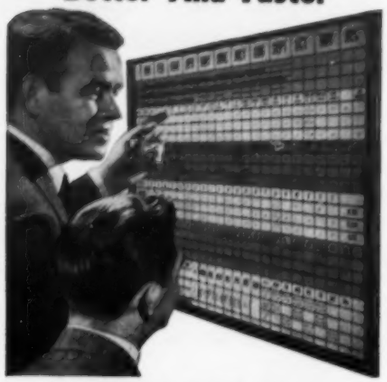

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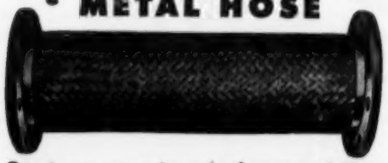

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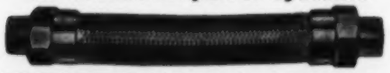

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# coming events

**Dec. 1-6:**
ASME Annual Meeting; Statler Hotel, New York City.

**Dec. 2-6:**
Exposition of the Chemical Industries; New York Coliseum, New York City.

**Dec. 8-11:**
AIChE Annual Meeting; Conrad Hilton Hotel, Chicago.

**Dec. 9-13:**
AIEE Joint Computer Conference; Shoreham and Sheraton Park Hotels, Washington, D. C.

**Dec. 18-19:**
Electronic Industries Association Conference on Maintainability of Electronic Equipment; University of Southern California, Los Angeles.

— 1958 —

**Jan. 6-8:**
National Symposium on Reliability and Quality Control; Hotel Statler, Washington, D. C.

**Jan. 20-24:**
AIEE Winter General Meeting; Statler and Sheraton-McAlpin Hotels, New York City.

**Jan. 27-29:**
ASHAE Annual Meeting; Penn-Sheraton Hotel, Pittsburgh.

**Jan. 27-30:**
Plant Maintenance & Engineering Show; International Amphitheatre, Chicago.

**Jan. 30-31:**
American Society for Engineering Education College-Industry Conference; University of Michigan, Ann Arbor.

**Feb. 2-7:**
AIEE Winter General Meeting; Statler Hotel, New York City.

**Feb. 3-6:**
National Industrial Electric Heating Conference; Netherland Hilton Hotel, Cincinnati.

**Feb. 16-20:**
AIME Annual Meeting; Statler and Sheraton-McAlpin Hotels, New York City.

**Feb. 24-28:**
ASCE Annual Meeting; Hotel Sherman, Chicago.

**March 2-6:**
ASME Power Division Gas Turbine Conference and Exhibit; Shoreham Hotel, Washington, D. C.

**March 17-21:**
NACE Annual Convention; Municipal Auditorium, San Francisco.


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| HP | MAKE | TYPE | RPM |
|---|---|---|---|
| 1200 | *Al-Ch. | ANY | 1800 |
| 600 | *G.E. | M-63456 | 1800 |
| 300 | G.E. | M-6345Z | 1200 |
| 250 | Al-Ch. | ARY-626J | 1800 |
| 250 | *G.E. | I-M-17A-10 | 720 |
| 200 | G.E. | I-M-16 | 600 |
| 200 | *West. | CW-950A | 514 |
| 150 | Cr-Wh. | 50R | 1800 |
| 150 | West. | CW-874C | 720 |
| 150 | Al-Ch. | ANY | 600 |
| 125 | G.E. | I-M-15A | 600 |
| 125 | *G.E. | I-M-15A | 600 |
| 100 | G.E. | I-M-E13A-4 | 1800 |
| 100 | G.E. | I-M-14 | 900 |
| 100 | *G.E. | I-M | 720 |
| 100 | G.E. | I-M-15A | 450 |
| 75 | North-W | EW-50 | 1800 |
| 75 | G.E. | MT-347-6 | 1200 |
| 75 | G.E. | I-M-13 | 1200 |
| 75 | G.E. | MT-356-8-75 | 900 |
| 75 | Al-Ch. | ANY-33C | 720 |

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3 phase, 60 cycle, 220 or 440 volts (* 2200 volts or higher)

| HP | MAKE | TYPE | PF | RPM |
|---|---|---|---|---|
| 1420 | West. | HG | 0.7 | 900 |
| 300 | G.E. | ATI-6-285M | 0.8 | 1200 |
| 300 | *Ideal | SMM | 0.8 | 257 |
| 275 | *G.E. | ATI | 1.0 | 450 |
| 250 | Al-Ch. | | 1.0 | 1200 |
| 225 | Elec. Machy | | 1.0 | 360 |
| 225 | G.E. | TS-6244 | 1.0 | 300 |
| 200 | G.E. | TS-7559 | 1.0 | 1800 |
| 190 | Elec. Machy | | 1.0 | 720 |
| 150 | Al-Ch. | SYN | 0.8 | 1200 |
| 150 | *Elec. Machy | | 0.8 | 1200 |
| 150 | *West | HR | 1.0 | 300 |
| 125 | *G.E. | TS-7641 | 1.0 | 514 |
| 125 | *G.E. | TS-6214 | 1.0 | 277 |

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|---|---|---|---|
| 100 | G.E. | MTC-5546-8 | 900 |
| 80 | G.E. | MTC-5552 | 600 |
| 50 | G.E. | HIC | 600 |
| 35 | G.E. | MTC-5536 | 600 |
| 25 | West. | CI-636-A | 720 |
| 15 | G.E. | ITC-5009 | 900 |
| 11 | West. | CI-E464-A | 900 |
| 10 | P & H | BW-6 | 1800 |
| 5 | North-W | WRC | 1200 |

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| 6000/3000 | Chandy. | 12/24—220/440 |
| 6000/3000 | Chandy. | 8/16—220/440 |
| 5000/2500 | Optimus | 6/12—220/440 |
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**Exclusive Lo-X Scarf-lap Construction** provides rigidity and strength. Tailored lengths overlap and bolt together easily. Elbows, tees and cross sections permit installation to fit specific plant layouts.

**The BullDog field engineer** stands ready with the detailed information you and your plant engineers may need to plan an efficient power network for new or existing facilities. Take advantage of his know-how in your planning.

# Aluminum Lo-X—low-cost key to electrical efficiency!

Leading industrial plants everywhere are using BullDog aluminum Lo-X feeder duct as a vital part of their electrical distribution systems. Invariably—this leads to increased electrical efficiency and savings right down the line.

First savings come with the initial investment in space-saving Lo-X BUStribution® duct! The lightweight, prefabricated aluminum sections cost less to buy—less to install. Next, current-carrying costs are the lowest possible . . . maintenance is reduced to almost nothing. Finally, reusable Lo-X can be relocated without loss if needs change. Consult your BullDog field engineer—see how a complete BullDog system, from safety switches to complete distribution systems, can be your key to real electrical efficiency and economy.

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**BullDog Electric Products Company, Detroit 32, Michigan • A Division of I-T-E Circuit Breaker Company • *Export Division:* 13 East 40th St., New York 16, N. Y. • *In Canada:* BullDog Electric Products Company (Canada), Ltd., 80 Clayson Rd., Toronto 15, Ontario.**

IF IT'S NEW . . . IF IT'S DIFFERENT . . . IF IT'S BETTER . . . IT'S

**BULLDOG**

**ELECTRIC PRODUCTS COMPANY**

A DIVISION OF I-T-E CIRCUIT BREAKER COMPANY

Circle 1108 on Reader Service card for more data

## PI reports

. . . starts on page 6

ground of technical data, have in many cases become clever with the drafting tools, and for this they can be very useful. But many of them lack one very important qualification . . . to concentrate on any specific point or problem to arrive at conclusions. In short, they have not gained the art of creativeness so essential to productive engineering . . .

"Our engineers should be taught how to THINK and not simply to read and recite. Thinking is the only factor in engineering that pays dividends."

Charles N. Albrecht
Industrial Sales and
Engineering Co., Inc.
Kalamazoo, Mich.

### Working with Bernoulli's Theorem

"Your article on 'Working with Bernoulli's Theorem', which appeared in October issue of POWER INDUSTRY, page 24, is very interesting as well as highly important.

"I will appreciate it very much if you can forward me a sketch of the problem involved showing the following: pump, levee, reservoir, the distance of 480 feet, the Datum line, and also the points (1) and (2)."

H. S. Manuel
Engineering Department
Chemical Construction Corp.
New York City

● *Professor James M. Robertson, Fluid Mechanics Basics author, will give additional help (within reason, of course) on this vital but complex subject.*

### Appointments, transfers, kudos in power industry

R. Lindley Murray, Hooker Electrochemical Co. board chairman, is recipient of Western New York Section AICE Professional Achievement Award. His engineering and executive ability and his service to AICE were cited.

Cooper-Bessemer Corp. names Dennis L. Gallogly assistant executive engineer. He will supervise company's Product, Development, and Technical Engineering Divisions. R. F. Kymer succeeds to chief engineer post vacated by Gallogly.

Joseph W. Lewis becomes assistant to Dr. Arnold O. Beckman, president of Beckman Instruments, Inc. Lewis has been manager of Arnold O. Beckman, Inc., for the past 6 years.

Federation of Sewage and Industrial Wastes Associations elects Kenneth S. Watson, president. Watson is General Electric Co. consultant on water management and waste control. He succeeds Emil C. Jensen, Washington state's engineering and sanitation head.

BLIZARD

MAECHTLEN

John Blizard, Foster-Wheeler Corp. research director, receives ASME fuels Division Percy Nicholls Award. Blizard was cited for his contributions to fuel utilization and heat transfer and for research on radiant superheaters, pulverizers, twin-furnace and forced circulation steam generators and heat exchangers for oil refining.

Square D Co. names Lawrence G. Maechtlen, first vice president. Company director and vice president since 1951, Maechtlen has managed company's Western Division for last 3 years. He joined company in 1926 as draftsman.

### AEC OK's Union Carbide's research reactor project

Atomic Energy Commission has filed notice of intention to permit Union Carbide Corp., New York City, to construct a research reactor at its research center in Orange County, N. Y. AMF Atomics, Inc. will design and build the 5000-kw pool-type thermal reactor, which is a modification of Bulk Shield Test Facility at AEC's Oak Ridge National Laboratory.

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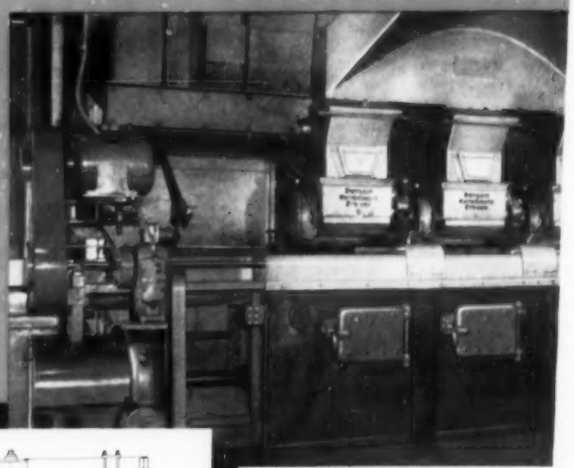
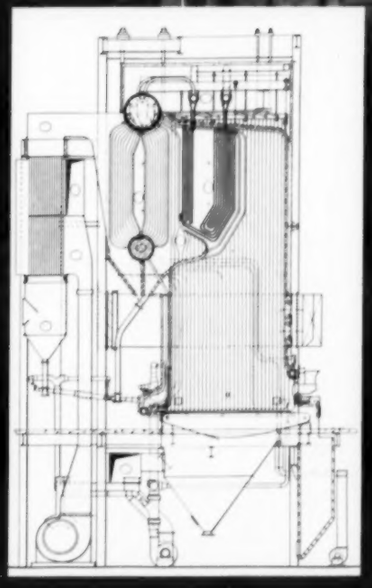
# Mile High Plant Steam Generator Fired By DETROIT ROTOGRATE STOKER

***Southern Colorado Power Co***





Note — This information is out dated. Another Roto Grate is being added here, to fire a new 200,000# per hour unit.

**This new unit which triples the capacity of the plant consists of a Babcock and Wilcox two-drum single pass steam generator fired by a Detroit RotoGrate Stoker having six feeders and distributors. The plant is at 5,300 feet above sea level. Capacity of above unit is 150,000 pounds of steam per hour at 660 psi, 915° steam temperature with preheated air at 350° F.**

**Design is based on bituminous coal:**

| | |
|---|---|
| **B.T.U. per lb as fired** | **10,828** |
| **Moisture** | **8.84%** |
| **Volatile matter** | **33.72%** |
| **Fixed Carbon** | **44.69%** |
| **Ash** | **12.75%** |
| **Sulphur (separately determined)** | **0.7%** |

**However, operation has been completely successful with coal from various mines in the vicinity.**

**Detroit RotoGrate is an exceptionally efficient spreader stoker with overlapping highly restricted grates that move slowly forward discharging ash at the front. Permits high burning rates with all Bituminous coals, Lignite or refuse fuels. *Write for Bulletin.***

***Southern Colorado Power Co.***
***Canon City, Colorado***
***W. C. Porter, Vice President in Charge of Operations***
***Chester Huskey, Superintendent***

***Stearns-Roger Manufacturing Co., Denver***
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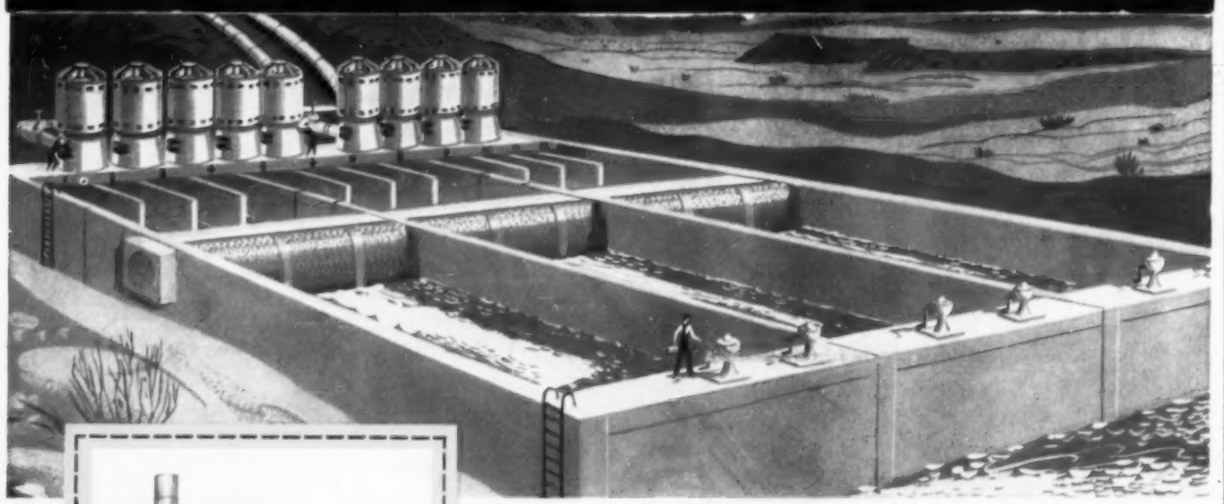
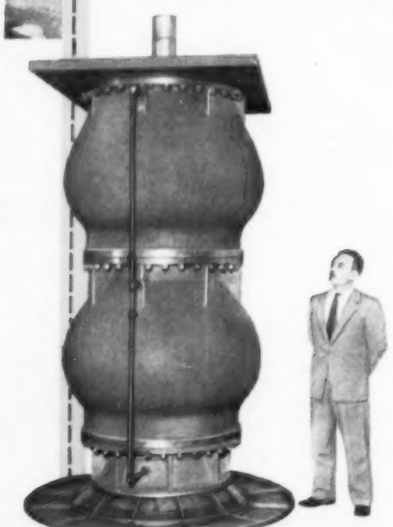
# Giant new Tidewater refinery selects Byron Jackson pumps for 400 MGD service





**TWO STAGE BJ PUMP** shown without discharge head and motor.

***SPECIAL ENGINEERING REPORT AVAILABLE:***

A special engineering report with detailed flow diagrams and color photographs is available. Also, a factual full-color motion picture report can be arranged on request.

Tidewater Oil Company's new Delaware Flying A Refinery is one of the world's largest new refineries. This giant refinery—15 miles south of Wilmington—will use more than 16 million gallons of water per hour. To accomplish this mammoth pumping job, Tidewater and C. F. Braun & Co. (engineers and constructors) selected nine BJ 2000 hp vertical river intake pumps, with provision for installation of three more units.

## *BJ Pre-Tested the Actual Installation*

Because of the special intake system and the untested hydraulic problems involved, it was decided to pre-test the actual pumping conditions. A scale model intake installation—including nine pumps—was constructed in Byron Jackson's Los Angeles hydraulic laboratory. Actual field operations were duplicated in this model. All tests confirmed the correctness of engineering and pumping specifications. In addition, before delivery, Byron Jackson performed exacting hydraulic tests on each of the nine pumps. *These giant pumps tested to an 89.5% efficiency!*

Each BJ pump will be driven by a 2000 hp electric motor at 600 rpm against a total head of 184 feet. Because of the brackish salt water, pump cases, columns and impellers are made of high alloy stainless steel.

BJ
SINCE 1872

**Byron Jackson Pumps, Inc.**
**A Subsidiary of Borg-Warner Corp.**
P.O. BOX 2017A, TERMINAL ANNEX • LOS ANGELES 54, CALIFORNIA

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